JUNE, 1938

Engineering and Mining Journal

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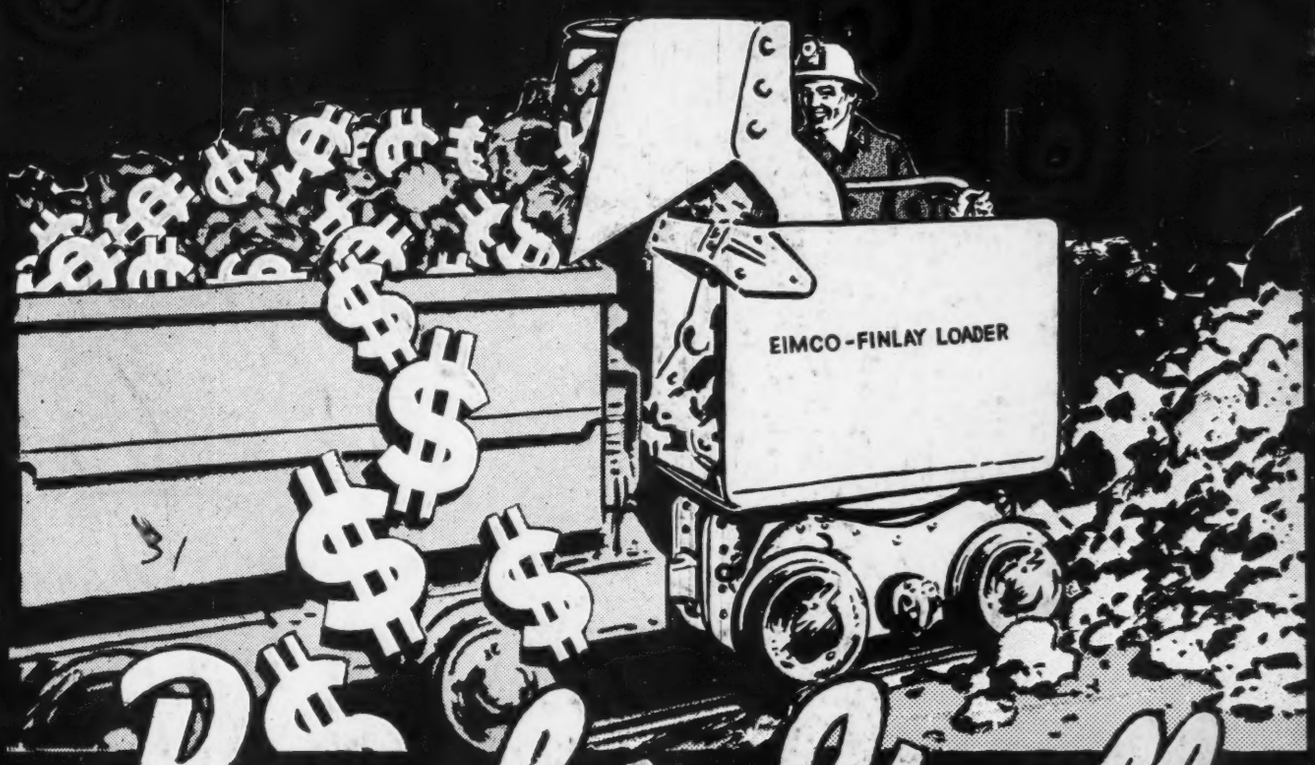

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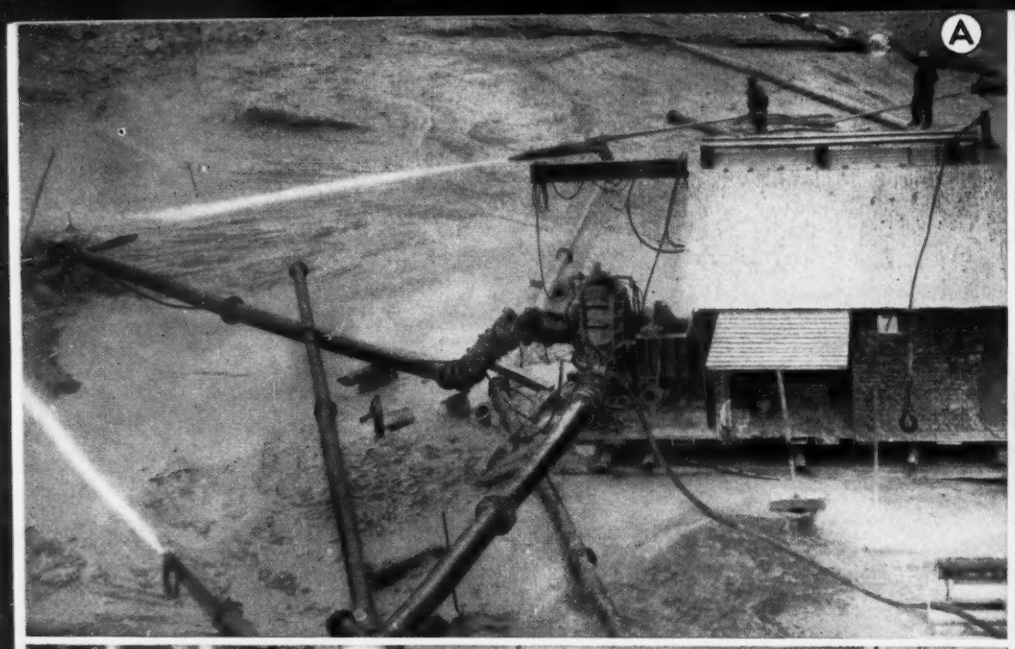

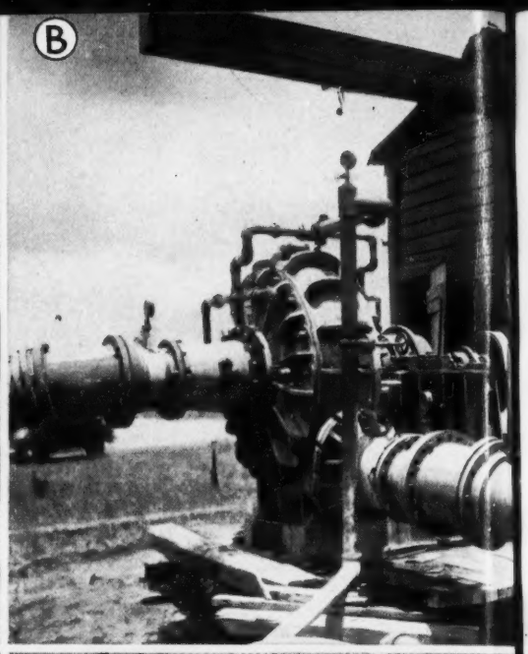

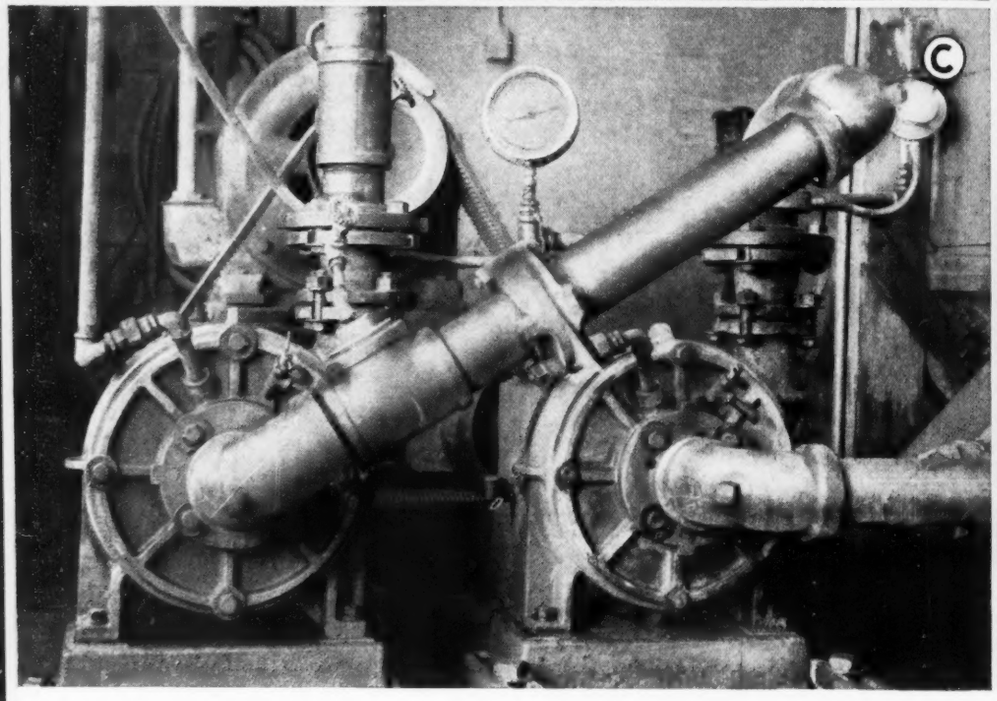

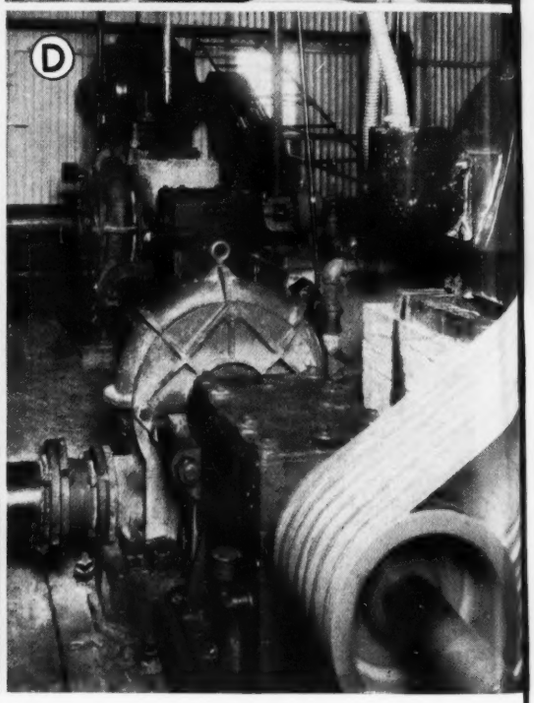

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Volume 139 Number 6

JUNE 1938

Sign of the Times

RECENTLY we sought to confirm reports of a substantial construction program by a Western mining company. The manager confirmed the plan, but not the appropriation or the decision to proceed. The latter are held in abeyance pending a return to conditions that will "warrant construction in the face of the so-called reform programs, and state and federal taxes. . . . We do not propose to expose the mill to the tax gatherers before we are sure we can utilize it." The incident is typical of conditions in American industry. Investment, production, and employment languish while spending and lending flourish at Washington. How loud must the chorus swell before it is heard by an Administration deaf to the pleas of industry that it be allowed to do a real job?

Mineral Policy and Battleships

IN A THOUGHTFUL ADDRESS before the American Zinc Institute last April, John Wellington Finch, Director of the Bureau of Mines, made some timely remarks on mineral policy and national defense. Reminding his audience that mineral raw materials are the foundation of industry, and consequently the keystone of national defense, he said that we still face an uncertain future with respect to deficient and strategic minerals. And this in spite of our bitter experience twenty years ago when, "by a combination of good fortune, bluff, smuggling, and other extreme measures the industrial machine was kept going."

Broadly speaking, Director Finch is on solid ground when he advocates a mineral policy based on developments of the past twenty years. In broad terms he proposes: (a) Government purchase of adequate stockpiles of strategic minerals for which we are dependent on foreign countries; (b) protection of such essentials as lead and zinc against foreign competition, even though domestic supplies are now meeting current demand; (c) discouragement of subsidies for peace-time exploitation of limited domestic resources of some strategic minerals that might better be preserved to meet an emergency; and (d) encouragement of research by the Government for the orderly development of such resources as we possess, by the annual appropriation of $500,000 to be used by the Bureau of Mines and the Geological Survey toward a permanent solution of our deficiency mineral problem. The cost of stockpiles would be not much more than for a modern battleship, and the research program could be supported for less than the interest charges on such a ship. With Director Finch we agree that "The time has come to face this problem with candor."

Congress also is of the same opinion, if we may judge from the provisions of S. 4012, introduced by Senator Thomas, of Utah. The bill is an orderly and realistic approach to the solution of the problem and deserves prompt enactment. It would effectuate the policies enunciated by Director Finch, and at a cost that is almost trifling in these New Deal days. Details will be found in our Washington news this month.

Public Relations—
Industry's No. 1 Job

NO ONE CAN DENY that "the American way of work and life" has brought to more people a higher standard of living than can be found in any other country in the world. And yet the authors of our system of private enterprise, and the system itself, are on the defensive. The reason? Because American industry has failed to do a job in public relations—has failed to educate the people, its customers, "to understand that their advanced standard of living is inextricably linked to the characteristic American plan of mass production in industry by which managements are forever striving to drive costs lower and lower to make more and more goods for more and more people." Such, at least is the theme of a recent address by Paul W. Garrett, director of public relations, General Motors Corporation, New York. We commend to every executive of American mining corporations a full reading of Mr. Garrett's address. A copy can be obtained on request to his

office. It is a convincing exposition of the subject, worth getting and reading.

Mining companies generally have neglected public relations for reasons that are obvious but not valid. Unlike the automobile industry, for example, the mining industry does not sell its products direct to people. But that is no excuse for not desiring and seeking the good will of the public. Indeed, the products of the mines so vitally affect the welfare of people and influence their standard of living that the need for public understanding and approval of the mining industry and its problems is of paramount importance.

And so it was refreshing and encouraging to note what William B. Daly, manager of mines for Anaconda Copper Mining Company, said at a session of the recent meeting of the Chamber of Commerce of the United States. There, before an audience of other industrialists and business men, people unfamiliar with mining, he discussed his company's personnel policies with respect to the health, safety, and general welfare of employees. He placed mining in a favorable light before his audience, and all who heard him must henceforth have a good word to say for the industry.

Incidentally, Mr. Daly's talk exemplified Mr. Garrett's thesis that public relations begin with employee relations; that employees are industry's first point of contact with the public; and that through them the public gains good or bad impressions of industry's general policies and practices. Mining needs more of the kind of public understanding and support that can flow only from publicizing its relations with people.

Thirtieth Anniversary

MARKED by cordial international relations in the mining fraternity, the Mining and Metallurgical Society of America celebrated its thirtieth anniversary in New York last month. A brillant assemblage of members and guests included Charles A. Banks, managing director, Bulolo Gold Dredging, Ltd., recipient of the Society's gold medal; James Y. Murdoch, president, Noranda Mines, Ltd.; E. J. Carlyle, secretary, Canadian Institute of Mining and Metallurgy; and Onesime Gagnon and J. S. McDiarmid, Ministers of Mines, respectively, for the Provinces of Quebec and Manitoba.

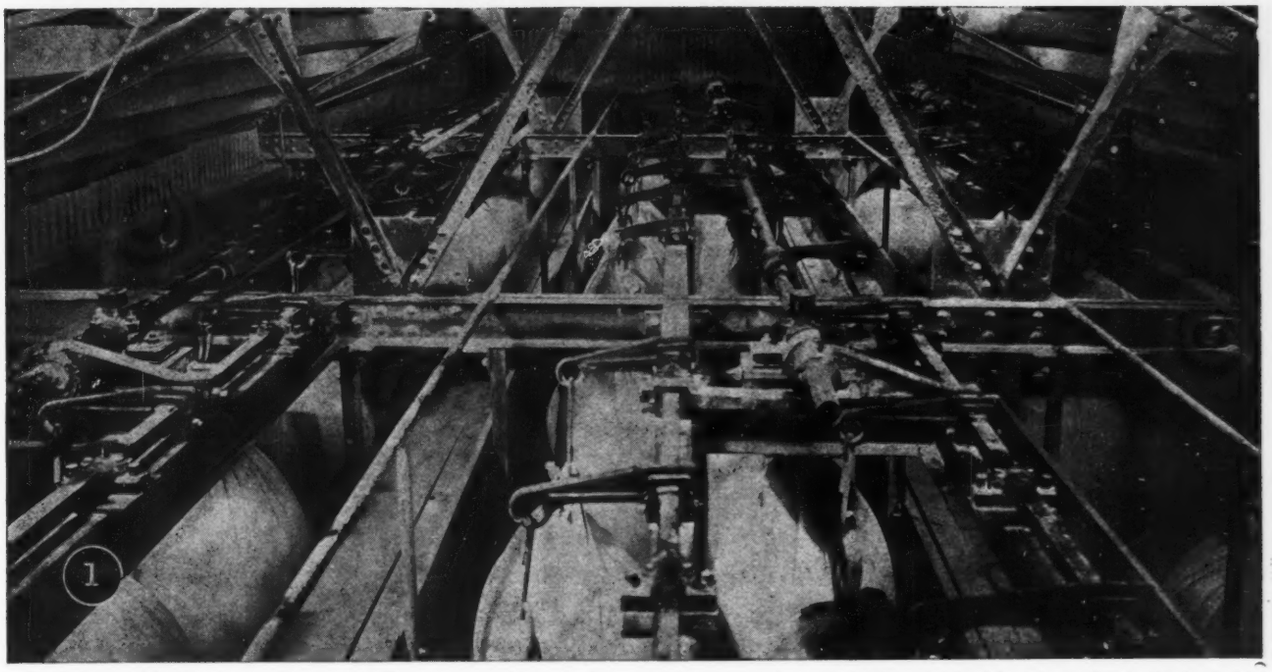
The Society's gold medal was presented to Mr. Banks "for distinguished service in the application of aerial transportation to the development of remote mining operations." His spectacular achievement in transporting 25,000 tons of dredge and power equipment by air to the gold field of Bulolo, New Guinea, has long since been publicized. But one gains an impression of the courage and ingenuity required in such a venture only by hearing Mr. Banks' personal account of the undertaking and seeing the motion pictures taken during its progress. The Society fittingly honored a worthy medallist. Mr. Murdoch's account of the development of Noranda, if less spectacular than that of Bulolo, was nevertheless characteristic of the vicissitudes of mining, and the financial courage and technical skill required to make a mine out of a prospect. On the whole, the Society's thirtieth anniversary was an exceptional event, celebrated in a manner greatly to its credit.

Engineers Launch Economic Forum

CLOSER COOPERATION between engineers and economists and other representatives of the social sciences is forecast in American Engineering Council's first forum at the Engineers' Club, Philadelphia, on May 13. The subject for discussion was "Employment and the Engineer's Relation to It," and the participants were engineers, economists, and industrialists.

This is the first fruit of a movement within A.E.C. to explore jointly with economists the common ground that lies between the field of the engineer and the field of the economist. As such it is a welcome activity, because the sensible solution of many a social-industrial problem needs the sympathetic understanding of these two groups. Each possesses talents and abilities not inherent in the other. Jointly they should become a more vital force in our social-industrial life than either can achieve alone. Thus far the engineers have, we believe, shown the broader vision, trying to comprehend economic problems and seeking solutions through their aptitude for factual study and interpretation. Some economists also recognize the need for cross-fertilization between the two groups.

Many current problems with which Government is struggling need the joint consideration of engineers and economists. No lasting political solution, for example, can ever be found for such industrial problems as wages and hours, volume of production and the more abundant life, the impact of technology on employment, social security, unemployment insurance, and many others. In all of them, social aims and philosophy must be reconciled with economic fact. If Council's first forum leads farther in this direction, more power to it.



IN THE BAGHOUSE—the shaking mechanism as seen from the top. The three sections are shaken separately by motors in background

An Automatic Baghouse For Dust Collection

At Pachuca, a new unit, of 30,000-c.f.m. capacity, serves Real del Monte's 200-ton-per-hour crushing plant at Loreto mill

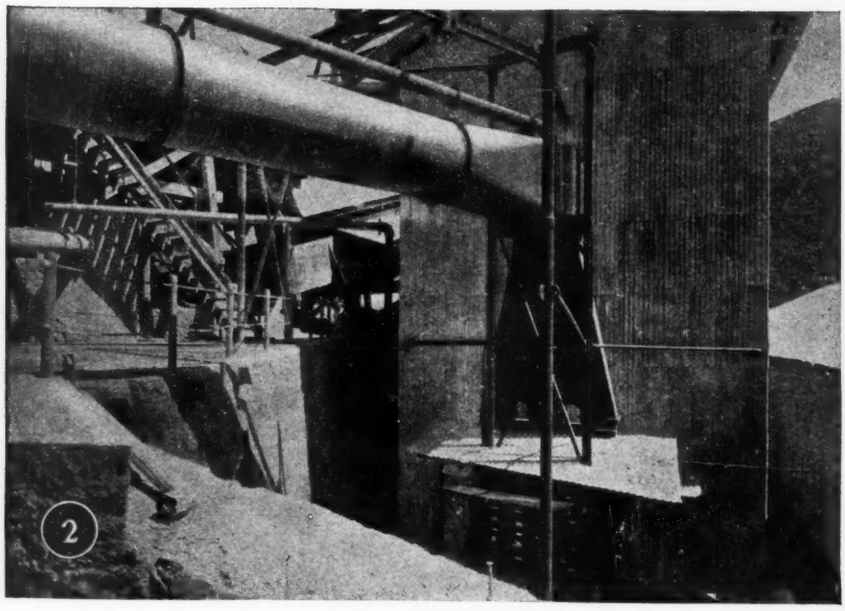
Alan Probert
Superintendent of Mills
Cia. de Real del Monte y Pachuca
Pachuca, Hgo., Mexico

AS A MAJOR PREVENTIVE measure in the continuous fight against silicosis, the Compañia de Real del Monte y Pachuca, at Pachuca, Hidalgo, Mexico, has made extensive improvements in dust-collection and dust-disposal equipment at the 200-ton-per-hour crushing plant of the Loreto mill. The principal points of interest are the completely automatic baghouse for separation of solids from the dust-laden air prior to its release into the atmosphere, and the utilization of bladed elbows throughout the duct system, these fittings being characterized by exceptionally high efficiency. The baghouse is essentially similar to standard fume-filtering equipment used at smelting units of the United States Smelting, Refining & Mining Company. The solid particles are comparatively much larger than those encountered in smelter fume, and the transporting air is cooler and more dense, resulting in a much smaller unit than is required for filtration at a smelter. A simple means for automatic control of this unit was devised, eliminating the necessity for workmen to enter the baghouse at any time during operation. The bladed elbows and fittings are of the type developed in the turbine research laboratory of the General Electric Company, the design and application of which have been ably described by Loring Wirt in the July, 1927, issue of the "General Electric Review."

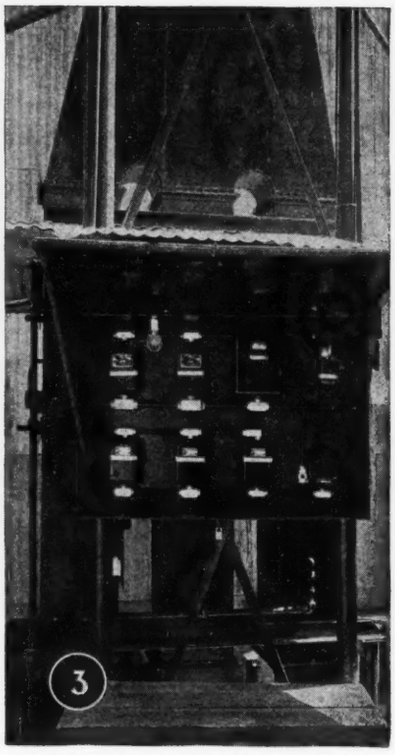
Dust gathered from the various hoods is drawn through a system of steel ducts with circular cross-section which converge at the fan intakes There are at present two American Blower Company steel-plate fans operating in parallel, the scroll cases and impellers of which have been locally protected against abrasion by application of Goodrich fabric-backed Armorite. These fans are being replaced by one heavy-duty, Type-E fan, size 80, furnished by the same manufacturer, fully rubber-covered at the factory, the present fans to be connected as a standby unit. The use of the larger fan will effect a small saving in power consumption, although the main reason for its installation is the economy anticipated in repairs due to lower operating speed with expected decrease in abrasion of wearing parts.

Discharge from the fans is through a horizontal 35-in. diameter round conduit which terminates in a bladed elbow that turns the air stream downward into a three-outlet distributor for division among the three sections of the baghouse. See photographs 2 and 3. Immediately adjacent to, and leading from, the distributor are three parallel 18-in. square ducts carrying the main section dampers with their control mechanism and the smaller by-pass valves in the 6-in. lines connected with the inlet of the fans to permit deflation of the bags by suction during the shaking cycle. These are illustrated by photographs 4 and 5.

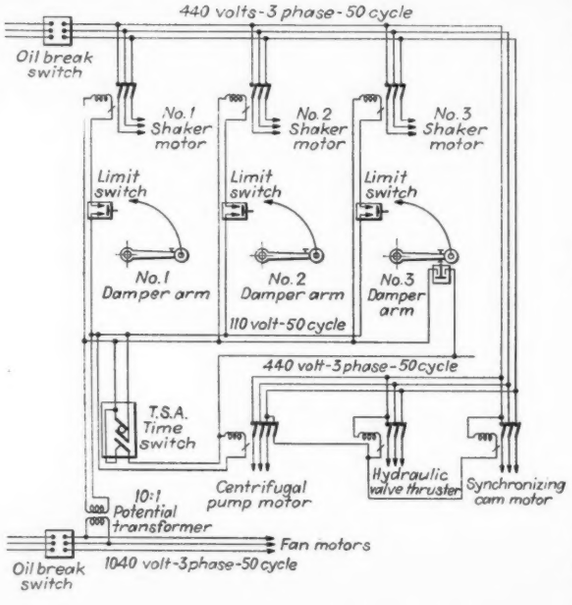
A steel thimble deck forms the cover for three triangular concrete hoppers that run parallel to the longi-



Dust-laden air is delivered to the baghouse from fans through the 35-in. diameter steel pipe shown



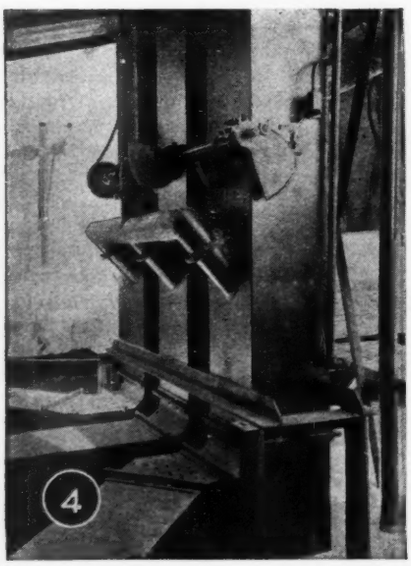
Electric time clock and switches for baghouse and auxiliary equipment



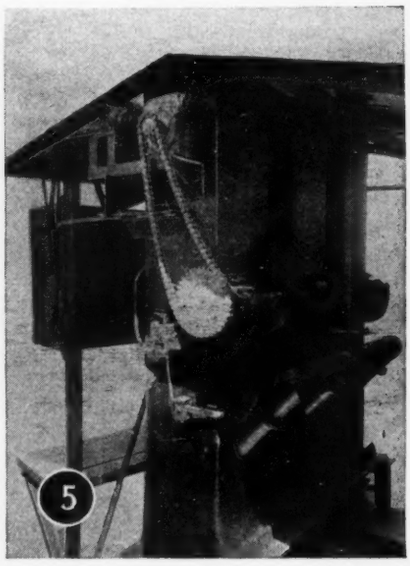
Wiring diagram for the baghouse used for dust collection at the Loreto mill

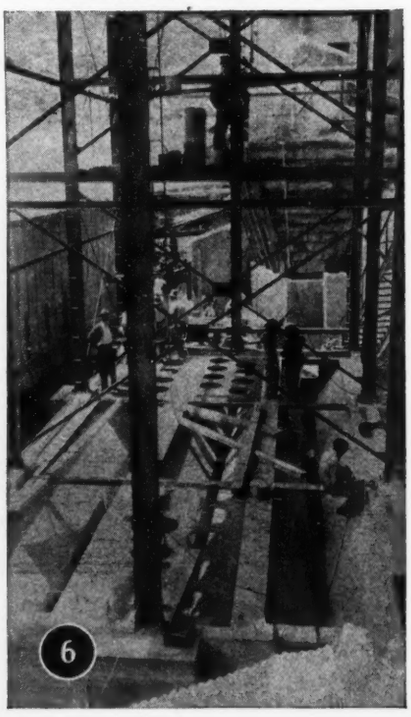
tudinal axis of the baghouse and which are an integral part of the foundation. These hoppers have sides inclined at 60 deg. which terminate in launders 8 in. wide which slope towards the air inlet end. Photograph 6 illustrates these hoppers, through which collected dust is sluiced out, using cyanide solution instead of water to avoid dilution

Thimble plates are being placed over the three hopper-shaped discharge launders, which receive the dust



Point of division (at left below) of air between three sections of baghouse. Below, the synchronizing camshaft and the drive mechanism



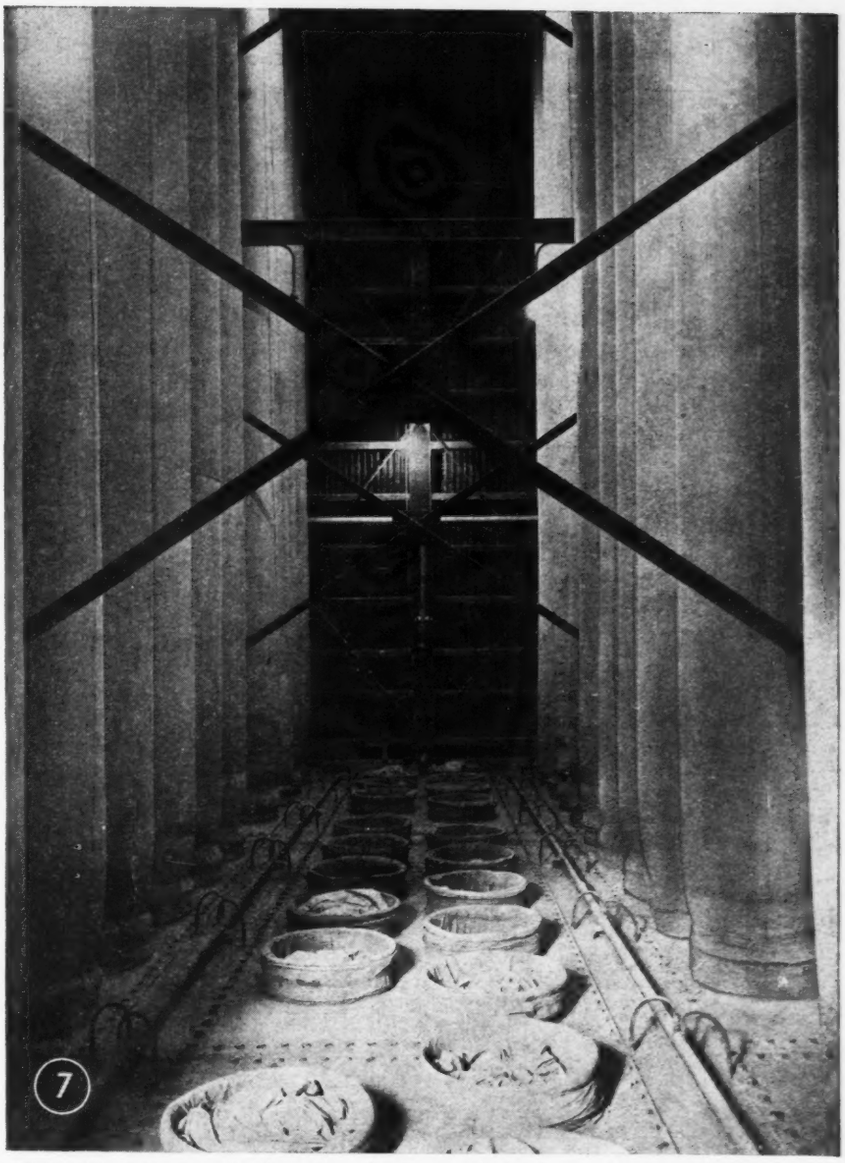


in the mill. The outlet from the launders is through short sections of 8-in. pipe dropping at an angle of 45 deg. through the end wall into an outside transverse launder. Escape of dust-laden air is effectively prevented by discharging under an 8-in. water seal maintained by a weir which is provided with a 3-in. pipe underflow having a flexible hose outlet counterbalanced to permit discharge of coarser settled particles during the period when solution is passing over the weir, but self-closing during the intervals of no flow.

Bag shaking is effected by a simple cam-operated mechanism, each of the three sections having a separate drive from a 3-hp. motor with built-in speed reducer. The 25 bags of each section are shaken by the same drive shaft, but the load is distributed into six parts, angularly 60 deg. apart, by the use of three single-drop cams spaced 120 deg. from one another. The six square shafts carrying the bag supports are actuated by arms that bear against these cams, one above and one below, as depicted in photograph 1, on page 29.

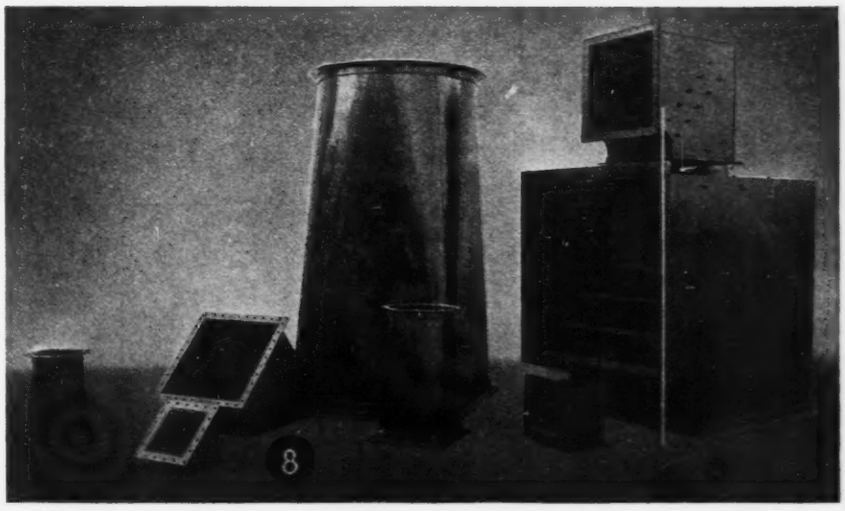
Control of shaking mechanisms with electrical interlock for synchronizing bag deflation and solution supply for dust removal is effected through the medium of a TSA-type time switch. This is shown, together with magnetic switches, in photograph 3. Power for operation of the switch solenoids is supplied by a small transformer, the primary of which is connected across the 1,040-volt fan-motor line, 110 volts being obtained from the secondary. This low voltage permits the use of standard elevator limit switches for remote control of the 440-volt motors operating the shaking mechanisms, synchronizing cam shaft and centrifugal pump without trouble from arcing. The use of the transformer prevents stopping the fans without shutting down the baghouse and guarantees simultaneous starting.

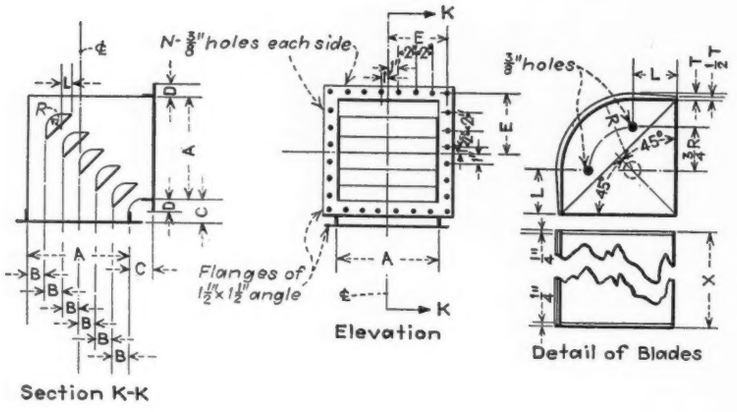
From photographs 4 and 5 the details of damper control can be obtained. The synchronizing cams are driven through a speed reducer and chain drive from a ¼-hp. motor with an additional built-in reduction. The camshaft completes one revolution in 5½ minutes, which is the over-all duration of the shaking cycle for the entire baghouse, repeated once each hour. Since the three sections are shaken separately, there is 3½ per cent lost time during which only two sections are operating; for the remaining 96½ per cent of the time the whole bag area is available and dampers are fully open. The 110-second cycle for any section is divided into the following periods: (1) 60 seconds for closing the main damper through 90 deg., the smaller bag-collapsing damper swinging through its 45 deg. arc during the last



THE BAGS of No. 2 section have been let down and the damper has been closed, so that the thimble floor, here shown, could be seen. The solution lines are visible above the floor

BLADED ELBOWS. The largest shown is 36-in., for connection to 35-in. round pipe by means of the adapter near by. See the drawings

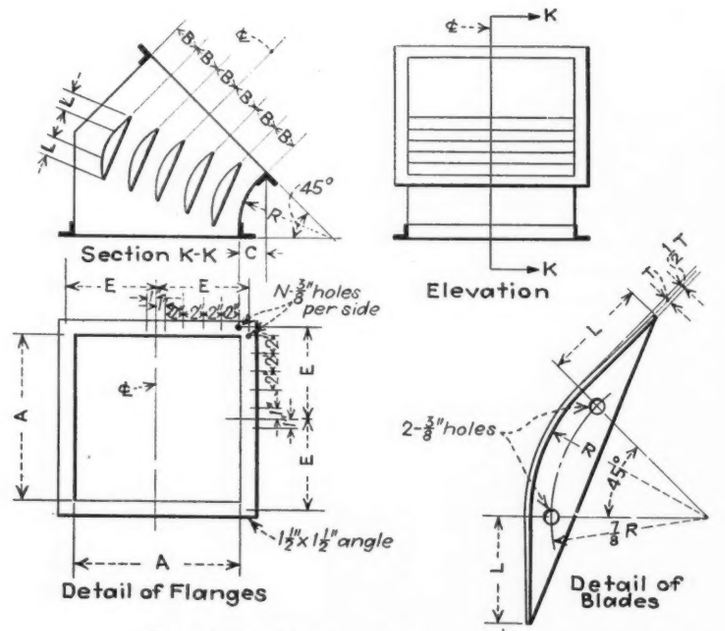




FIVE-BLADE ELBOW, rubber-lined and of square section, used on round pipes in crusher ventilating system. It is made from No. 10 gage sheet and welded throughout, blade assemblies being bolted into the elbow. Dimensions for 10 sizes are given

Round Pipe, Diam. Inches

		6	8	9	10	12	13	16	18	21	36
Size Opening	A	6	8	9	10	12	13	16	18	21	36
Blade Spacing	B	1	1 5/16	1½	1 11/16	2	2 3/16	2 11/16	3	3½	6
Offset	C	2	2 11/16	3 1/16	3 3/8	4 1/16	4 3/4	5 3/8	6 1/8	7 1/8	9 3/16
Flanges	D	1½	1½	1⅝	1½	1½	1½	1½	1½	1½	2
℄ Elbow to ℄ Bolt	E	4	5	5½	6	7	7½	9	10	11½	19
Blade Lip	L	¾	1	1⅛	1¼	1½	1⅝	2	2¼	2⅝	4½
Blade Radius	R	1 9/32	1 11/16	1 15/16	2⅛	2 9/16	2 7/8	3 7/16	3 7/8	4½	7¾
Blade Thickness	T	1/16	1/16	3/32	3/32	⅛	⅛	3/16	3/16	¼	¼
Holes per Inch	N	4	6	6	6	8	8	10	10	12	20
Blade Length	X	5⅛	7⅛	8⅛	9⅛	11⅛	12⅛	15⅛	17⅛	20⅛	35⅛



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℄ Elbow of ℄ Bolt	E	4	5	5½	6	7	7½	9	10	11½	19
Blade Lip	L	¾	1	1⅛	1¼	1½	1⅝	2	2¼	2⅝	4½
Blade Radius	R	1 9/32	1 11/16	1 15/16	2⅛	2 9/16	2 7/8	3 7/16	3 7/8	4½	7¾
Blade Thickness	T	1/16	1/16	3/32	3/32	⅛	⅛	3/16	3/16	¼	¼
Holes per Side	N	4	6	6	6	8	8	10	10	12	20
Blade Length	X	5⅛	7⅛	8⅛	9⅛	11⅛	12⅛	15⅛	17⅛	20⅛	35⅛

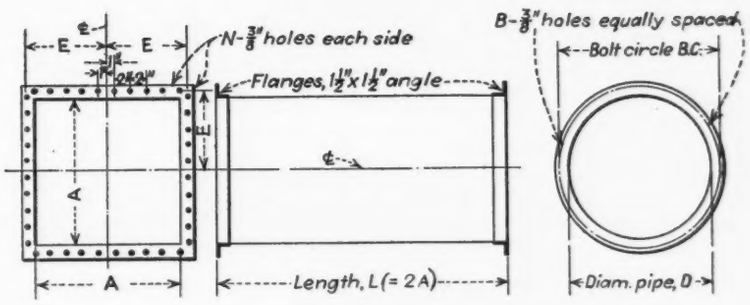
30 seconds of this period; (2) 40 seconds for shaking the bags at the rate of 90.6 shakes per minute; (3) 10 seconds for returning the dampers to running position after stopping the shaking mechanism. The sluicing of the dust, accumulated during an hour of operation, cannot be completed within 110 seconds without the use of an unduly large quantity of solution; therefore the pump operates during the entire 5½ minute cycle, electrically interlocked with the synchronizing cam motor. Solution supply was conveniently available from a near-by storage tank located above the pump. To insure closing off the solution at the end of the shaking cycle, a hydraulically operated discharge valve was installed which is controlled by an electrically operated high-pressure valve, this being connected to the pump motor.

In order that the shaking cycle will end exactly at the point where all dampers are in full open position, a limit switch was connected in parallel with the TSA timer contacts. The latter is set to cut in at 60-minute intervals, remaining in "On" position for only 4½ minutes. This allows the two first sections to shake and return to normal operation under time-clock control. As soon as the third section damper moves toward its closed position the limit switch comes into play and maintains the contact for control of the synchronizing camshaft throughout the remainder of the cycle. When this section reaches the end of its cleaning period, the damper arm swings back into place and breaks the circuit through the limit-switch control, the time clock having released 60 seconds earlier.

Everything except fans and pump that went into the construction of the dust collection and baghouse equipment was locally designed and built in the Real del Monte shops. Gear-reducer motors, switches, and other electrical devices are all standard units and were supplied by General Electric Company. Details of the standardized, square-bladed elbows, used throughout the system, are shown in the accompanying sketches, together with details of adapters used for connection of these fittings to the round ducts. To prevent stoppage of the openings by

FIVE-BLADE 45-DEG. ELBOW, of square section and rubber-lined, for use on round pipes. It also is made from No. 10 gage sheet, the seams being welded

STANDARD ADAPTERS for square-bladed elbows and round pipe. Flanges are made from 1½x1½-in. angle, and are riveted and braced to the side, made from the sheet metal in empty cyanide cases



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		6	8	9	10	12	13	16	18	21	36
Size Opening	A	6	8	9	10	12	13	16	18	21	36
Diameter	D	6	8	9	10	12	13	16	18	21	36
Length	L	12	16	18	20	24	26	32	36	42	72
℄ to Bolt ℄	E	4	5	5½	6	7	7½	9	10	11½	19
No. ⅜" Holes per Side	N	4	6	6	6	8	8	10	10	12	20
Diam. Bolt Circle	B.C.	8	10	11	12	14	15	18	20	23	38
No. ⅜" Holes in B.C.	W	6	8	8	12	12	16	16	16	16	32

waste and fuse which would lodge against the blades, a coarse screen is placed across the outlet of the pick-up hood; this does not seriously impede air flow and effectively keeps undesirable material from entering.

The original tests indicated that bags made from a locally woven, unbleached cotton cloth called *manta* would give satisfactory filtration at the rate of 0.4 sq.ft. per cubic foot of air per minute. Pressure built up within the bags varies from ⅝-in. water gage at the beginning to ⅞-in. at the end of one hour. There are three sections of 25 bags, each having an effective total filtering area of 4,000 sq.ft., or 12,000 sq.ft. in all. This area will permit the delivery of 30,000 c.f.m. without decreasing the interval between shaking periods to reduce pressure across the bags. The present delivery is 22,000 c.f.m., which will soon be increased to 25,000 c.f.m. by the installation of the fan previously mentioned, at a total differential pressure of 7-in. water gage and consumption of 50.4 hp. Air density at Pachuca is 0.055 lb. per cubic foot, and all measurements are made on this basis.

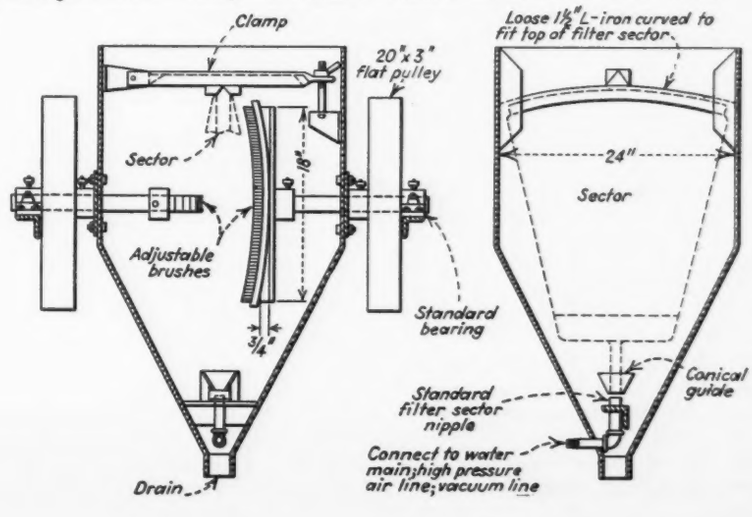
The degree of cleanliness of air within the crushing plant is greatly improved, as indicated by dust concentration measurements taken with a Leitz impact konimeter. Dust counts throughout the crushing plant show consistently below 300 particles per cubic centimeter, even within the baghouse itself. Immediately adjacent to the bags there is a concentration of 200 particles per cubic centimeter, just as the bags are being shaken, all of the dust smaller than 5 microns in diameter. Within 15 minutes this count decreases to less than 100 particles, all smaller than one micron. This dust is not returned to the crushing plant, as the baghouse is located outside and is housed in a separate building. The air exit from the baghouse is under the eaves along the sides. Even after installation of the larger fan there will be sufficient over-capacity to permit collection from additional points in the event of subsequent changes or alterations to the mill.

Disk Filter Sectors Scrubbed Mechanically

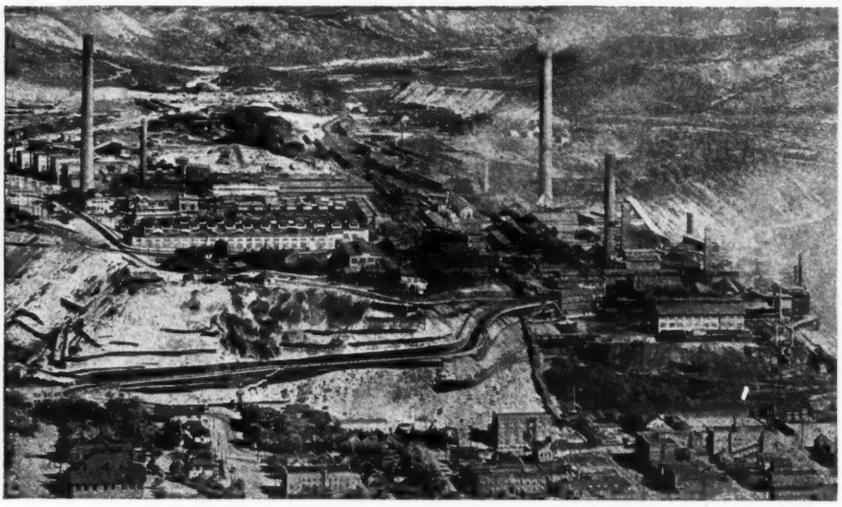
THE NEED for a more rapid and economical method for inspecting and scrubbing the sectors of the 6-ft. diameter continuous disk filters handling finished zinc concentrates at the concentrator of Consolidated Mining & Smelting Company of Canada, Ltd., Chapman Camp, B. C., Canada, prompted the mechanical department to develop the wet scrubber depicted graphically in the accompanying cuts. The device essentially consists of a square, hopper-bottomed tank made from steel plate, which contains two revolving brushes, and a simple clamp arrangement at the top of the tank and a conical guide and a standard filter sector nipple secured to an angle iron at the bottom of the tank to align and hold the sector to be scrubbed.

Motive power is transmitted to the 20-in. pulleys mounted on steel shafts operating in standard bearings attached to the sides of the tank by a small electric motor fitted with a reversing switch. Distance between the brushes is adjustable by simply sliding each brush to a desired point and then tightening the setscrews. The brushes revolve in the same direction at 60 r.p.m. The filter sector nipple extension at the bottom of the tank is connected to the water main, high-pressure air and vacuum lines, with a valve arrangement making possible the operation of one or the other.

Method of operation is as follows: The filter sector is placed in the tank and clamped down. Next, the brushes are revolved and water and high-pressure air turned. During this operation care must be taken not to use too much air, lest the water be backed up in the mains. The direction of the brushes is then changed. When the sides of the filter sector are clean, the water and air are turned off, the brushes stopped, and the vacuum is turned on to drain the sector.



Producing Lead at Trail



THE TADANAC SMELTER at Trail, B. C., a general view. This plant is one of the most complete of its kind in the world

A Description of the Smelter and Refinery as It Is Today

John B. Huttl
Assistant Editor

CONCENTRATES produced by the Consolidated Mining & Smelting Company of Canada at its Kimberley concentrator, and custom ores received from neighboring mining districts, are smelted at the company's reduction works at Trail, B. C. The distance from Kimberley to Trail is about 200 miles. Since completion by the Canadian Pacific Railway of the rail section along Kootenay Lake between Procter and Kootenay Landing (formerly connected by a boat service), an all-rail route between the mine and smelter has been established. At Trail also are the executive headquarters of the company, from which are directed the different mining and exploration, milling, and reduction units. The smelter itself is not a new plant, for its initial construction dates back to 1895. Originally, only ores from the Rossland mines were treated. The plant was enlarged in 1898 and in 1901 began to treat lead ores in addition to the copper ores. It was enlarged further in 1906 after acquisition by the present owners. Subsequent additions and improvements have made the smelter one of the most complete metallurgical works in the world.

The plant is built on a comparatively narrow terrace along the west bank of the Columbia River, and covers about 160 acres. At the time of my visit in October, 1937, the two principal smelting departments—that is, lead and zinc—were producing 560 and 375 tons of metal a day respectively. Silver production amounted to 25,000 oz. a day, and the monthly output of gold was 4,500 oz. and that of cadmium 25 tons. In addition, a small amount of bismuth metal was recovered from refinery by-products, and about 60 tons of elemental sulphur per day was obtained from new sulphur dioxide plants completed recently. Exclusive of the fertilizer department, which employs some 560 men, the smelter provided work for 3,200 men.

As mentioned previously, the bulk of material handled at the smelter is that received from the Kimberley operations, and consists of finely divided lead and zinc concentrates. Custom ores and concentrates treated amount to roughly 7 per cent. The reduction plant proper is divided into two major parts—namely, a lead smelter and a zinc smelter, both units being practically self-contained. All buildings are connected by a network of standard track on which trains are operated, and auxiliary service is provided by electric trolley locomotives on narrow-gage tracks. Concentrates from Kimberley are received in trains of steel bottom-dump cars, which are switched from the main line to the respective unloading plants.

At the lead smelter storage and sampling facilities consist of a series of partitioned storage bins, stockpile areas for coke and ore, bedding bins, and a sample mill. Drawing, transportation, and bedding of materials are effected by automatic feeders, belt conveyors, and automatic trippers. Owing to the fact that a zinc-plant residue containing more than 10 per cent lead and 21 per cent zinc is treated in conjunction with the regular lead concentrates and custom ores, the metallurgy at the lead smelter differs considerably from that practiced at other plants. Briefly, the method of treatment involves double sintering, smelting in blast furnaces, and slag fuming for additional recovery of lead and zinc.

Of more than ordinary interest is the method of preparing sinter. Rich lead concentrate assaying as high as 71 per cent lead, but relatively low in zinc and iron (3.9 and 6.3 per cent respectively), and the zinc plant residue mentioned previously, are thoroughly mixed on two mixing tables before going to the primary sintering plant containing six Dwight-Lloyd machines, each 600x42 in. The charge to these units, neglecting returned sinter, contains from 49 to 55 per cent lead, 6 to 7 per cent zinc, and 14 per cent sulphur. Depth of the bed is 6½ in., and ignition is accomplished by oil burners operating in a small furnace, hemispherical in section, situated above the bed a short distance in front of the feed position.

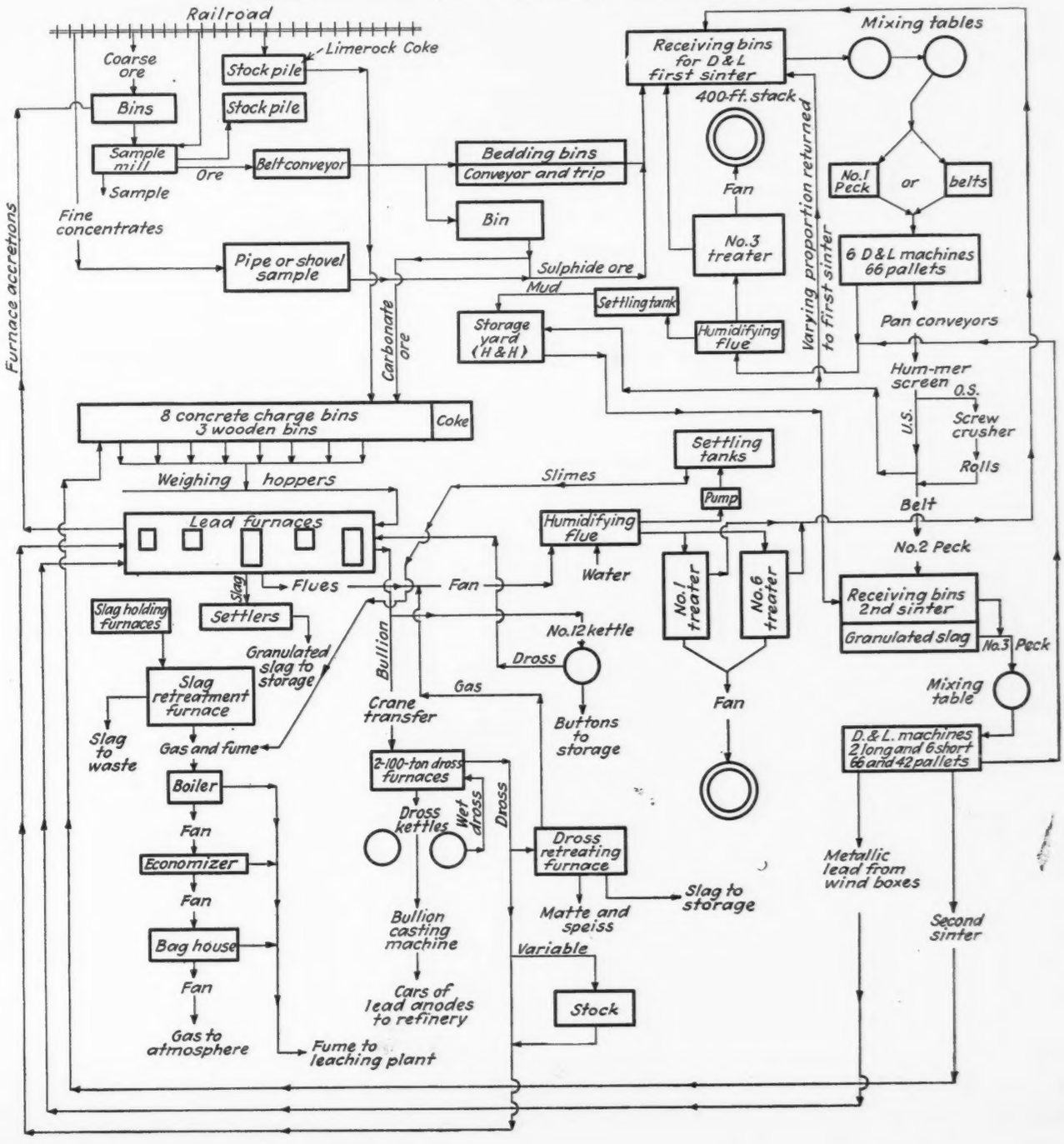
Primary sinter is passed by pan

feeders over a Hum-mer screen, the undersize going direct to the receiving bin at the secondary sintering plant, and the oversize being reduced to proper size by a screw crusher and a set of rolls. A daily composite sample is taken of the crushed sinter, primarily for determining the sulphur content, which is about 6.5 per cent. To improve the quality of the sinter as to hardness, granulated slag in amounts varying inversely as the lead content is added to the secondary sinter feed. Both products, drawn from respective bins, are thoroughly mixed on a third mixing table and then sent to the secondary sintering plant. Here, two 600x42-in. and six 264x42-in. Dwight-Lloyd machines are available. On these a bed of 9½ in. is maintained, and ignition is accomplished in a manner similar to that on the primaries. Sulphur is reduced to around 2 per cent.

Secondary sinter goes to the storage plant consisting of eight concrete and three wooden bins for materials to be charged to the blast furnaces, and a bin for coke. The concrete bins are equipped with pan conveyors or belts, which dump drawn material into center-dump weigh hoppers. From these each ingredient in turn is delivered to any of the six 48-cu.ft. V-bottom cars of the charge train drawn by an electric trolley locomotive. The charge consists of 2,550 lb. sinter, 350 lb. wet slimes from zinc-plane residue or smelter flues, and 275 lb. coke (80 per cent fixed carbon). Daily production of sinter amounts to about 1,300 tons.

Blast-furnace equipment consists of one furnace 48x180 in., one 48x270 in., two 60x180 in., and one 60x270 in. All are charged from the side through water-cooled and air-operated doors suspended from the hood, which has vertical sides, a sloping top, and a 9-ft. outlet at the center of the top. The offtake flue is of the gooseneck type. Each charge door and the

OPERATIONS in the lead plant at Trail proceed according to this flowsheet



water-cooled portions of the hood are connected to a Nesmith vaporizer on the main hood frame. Furnace shafts are of the water-jacket type, with the water-cooling system connected to a Nesmith vaporizer.

There are 24 2½-in. tuyeres on a side on the short furnaces and 36 on the long ones, 4 tuyeres to each water-jacket section. The lead well is a short distance back of the tapping jacket. The main body of the crucible is filled with coke-breeze concrete of a 1:2:3 mix (1 part cement, 2 sand, and 3 coke, all minus 1 in.), followed by a 3-in. layer of Sil-O-Cel concrete, and the refractory lining of required shape consisting of 12 in. of lumnite concrete. The water-cooled tapping jacket contains a removable cast-iron plug, to facilitate barring of crucible crust from the front. A siphon lead tap is opposite the second jacket from the tapping end. Metallic lead flowing continuously from the crucible first goes to a receiver below the tap spout, and thence to 5-ton pots in the slag aisle. These are transferred at intervals to the drossing plant by overhead cranes serving the furnace floor.

Of the five furnaces available, four are in operation. Total capacity is 800 tons of lead bullion a day, and all furnaces are operated on a 40-oz. blast. Current smelting practice and furnace construction are the result of investigations conducted over a period of years. Factors responsible for the increased furnace output, smoother running conditions, and lower coke consumption are (1) thorough preparation of the sinter, (2) wider furnace shafts, (3) use of a larger number of tuyeres of smaller diameter, and (4) slags with a higher lead content. The wider shaft reduces "hangs" and gives better air distribution, and more and smaller tuyeres permit harder driving and effect better air distribution. Slags with a higher lead content (about 3.5 per cent) have reduced coke consumption from 11 to below 10 per cent of the charge. The higher lead content of the slag is not an objectionable feature, because the lead is recovered in the slag-fuming furnace to be described later.

Furnace capacity has been increased from 30 to 50 per cent. Slags from the furnaces average Ag, 0.10 oz. per ton; Cu, 0.15 per cent; Pb, 3.5; S, 1.5 to 2.5; Zn, 16.5 to 18; SiO_2, 19.0; Fe, 30.5; CaO, 7.5; Al_2O_3, 5.0; MgO, 1.5; and Mn, 0.6. The relatively low lime and silica content of the slag is due to the fact that Sullivan products, which constitute the major portion of the charge, contain very little of either material. Under present practice, a slag with 19 per cent silica and 7 to 8 per cent lime is considered normal. However, siliceous ores, ⅜ in. in size, are charged direct to the furnace whenever the silica content falls below 18 per cent. Zinc-to-iron ratio in the slag is maintained at 1 to 1.7 or 1.8.

Of considerable interest to the visitor is the slag-fuming plant near the blast-furnace department. Though a separate unit, it is nevertheless an intimate part of the lead smelter, and since its completion in 1930 the fuming furnace has operated 95 per cent of the time. As equipped, the plant comprises two 40-ton holding furnaces to keep the blast-furnace slag hot between fuming furnace charges, a 600-ton fuming furnace and auxiliaries, waste-heat boiler, economizer, and a suction-type baghouse. The fuming furnace, 10 ft. wide, 24 ft. long, and 10 ft. high, is of water-jacketed construction, with a Nesmith vaporizing system controlling the jacket water. On each side of the furnace are 36 double-inlet tuyeres through which coal and air are introduced, a 40-ton cylindrical steel storage bin for coal, and five feed or pressure tanks. Coal pulverized at a central plant is delivered by the Quigley system to the larger bins, whence it is fed to the pressure tanks. Screw feeders at the bottom of each tank, driven by a single motor attached to a locally made variable-speed transmission, drop the coal into injectors operating under 80-lb. air which in turn direct it through 2½-in. transport pipes to headers at the furnace, each supplying eight or nine tuyeres through ¾-in. pipes. Dog clutches on the feeder transmission line permit any or all feeders to be stopped for tank filling or repairs. A rotary blower with volume regulator supplies air at a constant volume of 15,000 cu.ft. per minute at a pressure from 4 to 8 lb. per square inch.

Slag tapped from the blast furnaces is stored in the two holding furnaces to prevent excessive production of pot shell. There is one furnace for each two blast furnaces, and both have hearths measuring 10 ft. 6 in. by 18 ft. The part above the slag line is of firebrick, with the lower wall water-jacketed. Coal consumption is about 6 tons per day per furnace, and shell production from 15 to 20 per cent, depending on the condition of the slag. Furnace gases are directed through a brick-lined steel stack to the blast-furnace balloon flue.

Operation of the fuming furnace is continuous—that is, a slag batch is introduced, treated, and withdrawn, to be followed by another. The slag, tapped from the holding furnace through a 12-in. slot into cast-steel pots, is transferred quickly by a 20-ton crane to the fuming furnace at one end of the crane aisle. Each charge consists of about ten pots of slag, or from 65 to 70 tons. The treatment cycle is 155 min., of which 20 min. are required for charging, 125 min. for blowing the full charge, and 10 min. for tapping. Coal feed remains constant throughout at about 6 tons per hour. Slag discharged below the tuyere level through two 5½-in. water-cooled tap holes is granulated in a stream of water; and pot shell temporarily stored in a 100-ton bin at one end of the blast furnace floor is returned to the blast furnaces.

Frequently, granulated lead furnace

TUYERES and tap hole of one of the five lead blast furnaces. The latter range from 48x100 in. to 60x270 in. in size. Four furnaces were in operation at the time of writing

slag is treated in conjunction with molten blast-furnace slag. About 2½ tons of granulated lead furnace slag blown in above the charge will replace 6½ tons of hot slag, with the same resulting elimination rate. The amount to be added to a charge deficient in hot slag is determined by an estimate based on 85 per cent zinc elimination in a normal cycle. Total lead and zinc recovery is 98 and 85 per cent respectively, and treated slag assays 0.03 per cent lead and 3.4 per cent zinc.

Boiler equipment consists of a 1,735-hp. B. & W. Stirling boiler, which is connected to the fuming furnace uptake by a short brick flue with clean-out doors. Gases enter the boiler at 2,200 deg. F. and leave at 630 deg. F., or less, after which they pass through a Green economizer comprising 1,008 cast-iron tubes, 4 in. inside diameter and 12 ft. long, arranged in 84 banks twelve tubes wide. Draft at the furnace throat is maintained at 0.3 in. water gage by a paddle-wheel fan driven by a variable-speed motor. From the economizer the gases are withdrawn at about 250 deg. F. and directed to a Dracco baghouse installation by a fan capable of handling 300,000 cu.ft. of gas per minute, and operating at 2-in. water gage. The eight ten-compartment units of the baghouse contain 1,440 bags made from llama wool, and the maximum temperature at which the gases are allowed to enter the bags is set at 220 deg. F.

All flues of the gas distribution system are hopper-bottomed. Collected fume is discharged by gravity through special gates at the bottom of each hopper and trammed in 58-cu.ft. V-cars to the oxide leaching plant. Filtered fume from the baghouse is delivered by screw conveyors to a belt conveyor discharging into an elevated loading bin, whence special closed 2,620-cu.ft. standard-gage cars carry it to the oxide leaching plant.

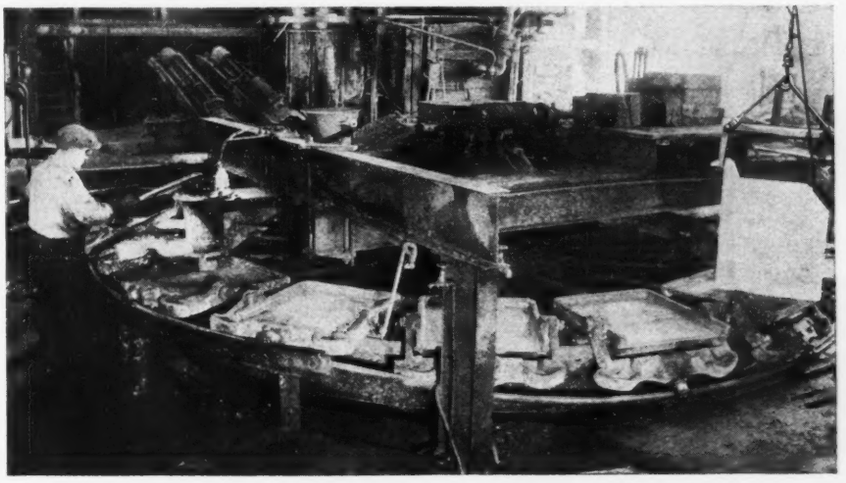
Clinker fines go to the zinc plant for crushing and leaching, and the coarse material, after crushing, is returned to the fuming furnace.

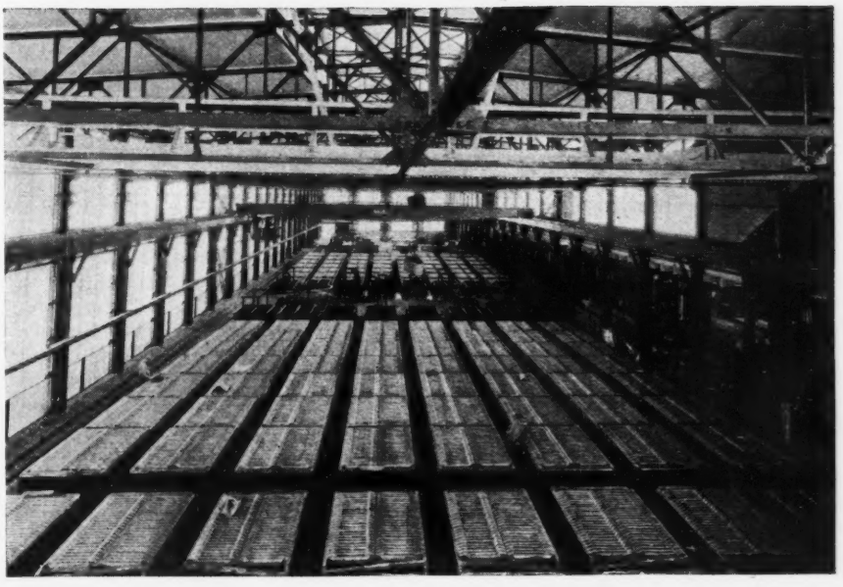
Gases leaving the baghouse at about 90 deg. F. are discharged into a 100-ft. stack by a third fan. All fans operating in the plant are automatically controlled. Economizer water circulation is adjusted to take a maximum heat from the gases, and additional cooling, when necessary, is accomplished by admission of outside air. The boiler produces about 60,000 lb. of steam per hour at 185-lb. pressure. Gases from the blast furnaces and sintering machines are treated in three Cottrell dust-recovery plants before being released to the atmosphere through two stacks 256 ft. and 400 ft. high, respectively.

At the drossing plant, bullion brought from the blast-furnace floor in 5-ton cast-steel pots is successively treated in either one of two 100-ton drossing furnaces and three 60-ton kettles, from which it is pumped to a 100-ton casting kettle serving an 18-ft. anode casting wheel. Dross from the drossing furnace is skimmed into pots with perforated bottoms, the dry dross being re-treated in the blast furnace until the copper content has reached a point to warrant treatment in a re-treatment furnace; and the bullion that escapes through the holes and collects under the pots is re-melted in the 60-ton kettles.

Dross removed from the cooling kettles is returned to the drossing furnace. This unit and the dross re-treatment furnace are fired with pulverized coal. Matte and speiss produced by the latter unit and containing about 22 per cent lead and 56 per cent copper are periodically shipped to the A. S. & R. smelter at Tacoma, Wash.

Anodes cast at the drossing plant are refined by the Betts electrolytic process. The present refinery is the outgrowth of a relatively small pioneer plant first operated in 1903. There are two separate buildings housing the tank, lead-melting, and casting equipment. As operated, the tank-house contains 1,116 cells arranged in thirteen cascades, each made up of either six or eight rows of double cells. These are constructed of reinforced concrete, with all parts exposed to the electrolyte protected by a thin layer of asphalt applied on a coat of asphalt paint (primer). Pipes and fittings handling electrolyte are of hard rubber, and copper and Monel metal pumps are used exclusively for distribution, sump, and storage ser-





LEAD REFINING at Trail is done by the Betts electrolytic process. The refinery comprises two buildings, of which the tank house is seen immediately above. In the upper picture is shown the casting of the unrefined lead in the form of anodes in the drossing plant. The 18-ft. wheel is served by a 100-ton kettle. Anodes average 98.75 per cent lead

vice. The electrolyte circulated through the cells at a rate of 3 to 4 g.p.m. is a solution of lead fluosilicate and hydrofluosilicic acid, a representative analysis of which is as follows: Specific gravity, 1.210; lead, 67 grams per liter; free H_2SiF_6, 95 grams per liter; total H_2SiF_6, 142 grams per liter. Its temperature is kept between 35 and 45 deg. C.

The anodes treated at the refinery average gold, 0.423 oz. per ton; silver, 49.9 oz. per ton; copper, 0.035 per cent; lead, 98.75; antimony, 0.63; arsenic, 0.31; tin, 0.038; and bismuth, 0.04. Each tank contains 24 anodes with a combined weight from 8,900 to 9,200 lb. They are spaced 4.125 in. center to center, and the submerged area of each anode measures 30.125x26.25 in. The starting sheets are made manually at a near-by plant and are 39 in. long and 26.75 in. wide (submerged area 31.55x26.75 in.). Contact with the 1x½ in. copper bars resting on the busbars proper is made by wrapping one end of the sheet 1½ turns around the bar. Current on the busbars is maintained at 5,300 to 5,500 amp., and the density per square foot at 18.5 to 19.43 amp. Voltage drop between the cells varies from 0.35 to 0.60 volt.

All sections of the refinery are operated on the basis of a six-day anode, a three-day cathode, and three-day anode slimes. The cathodes are removed after a three-day electrolysis, washed, and delivered to large melting kettles. Anode scraps, on the other hand, are washed in special machines, then melted, and finally recast into anodes. The slime removed from the anodes is washed in perforated basket-type centrifuges for the recovery of electrolyte prior to being sent to the silver refinery. Cathodes are melted in 235-ton welded-plate kettles fired with pulverized coal, then heated to 950 deg. F. and treated with compressed air to eliminate the small amounts of arsenic, antimony, and tin contained, the blowing operations requiring from 20 to 40 min. After the refined metal has been cooled to about 780 deg. F., it is pumped direct into the molds of a 20-ft. casting wheel. More than 550 tons of metal are produced a day.

Anode mud or slime with a moisture content from 35 to 40 per cent is treated in the silver refinery in a series of furnaces, the base metals being successively eliminated by oxidation. Eight conventional units are available for this work. The resulting doré bullion is parted in iron kettles using 66 Bé. sulphuric acid. Products derived at the plant are antimony, bismuth, silver, gold, and antimony-lead slag, which is re-treated at the smelter. The copper smelting and refining departments of the lead smelter are not at present in operation.

Stemming Has Advantages In Blasting the Round

And use of a safety plug such as described improves results

Reed E. Roberts
Superintendent, Zacatecas Unit
The Fresnillo Company
Zacatecas, Zac., Mexico

THE IDEAL CONDITION in blasting with respect to the charge in a drill hole is to have the resistance back of the charge equal, or as near so as possible, to that at the sides of the hole—this to get maximum results. I have found a safety stemming plug most valuable, with respect to safety and efficiency. With its use the old excuse of a misfire being dangerous to shoot is eliminated. The Voortmann plug, which I have used, consists of a cylinder of hard non-inflammable material with a cavity at one end and a central longitudinal hole through which passes a non-inflammable cord knotted at one end, the knot being larger than the hole and lying within the cavity. The plug diameter is slightly less than that of the borehole and provision is made so that the fuse or the detonator wires in electric shot firing can pass between the outside of the plug and the borehole wall.

The plug forms part of the stemming. It is placed in the borehole, held firmly in the required position by the cord, and damp clay, which is best, or sand and clay, is tamped firmly against it. It is pulled back slightly to embed it firmly in the clay, and tamping is completed with more clay, always rammed tightly. By this means protection is given the primer cartridge and detonator, and any possibility of the detonator being struck by the tamping stick is prevented. The stemming can be packed tightly against the plug, which is held by the string meanwhile.

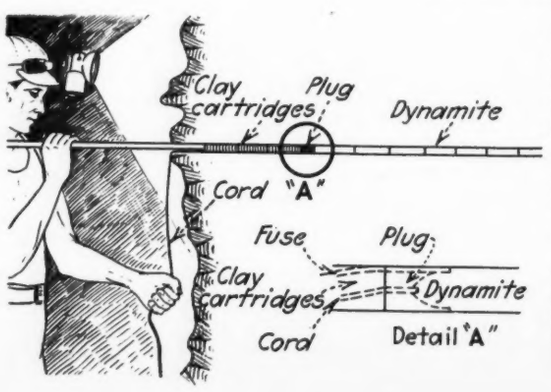


Fig. 1 . . . THE SAFETY PLUG forms part of the stemming, as seen here. Details of the part of the charge within the circle are shown in the lower right

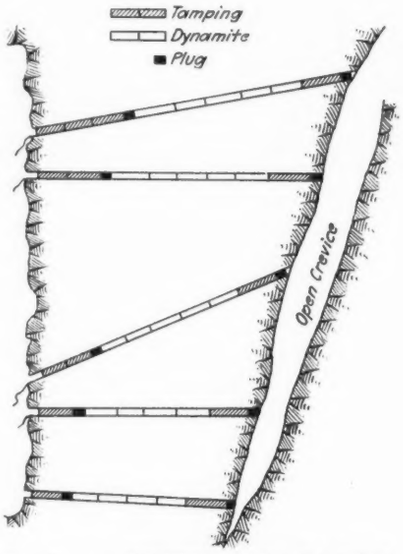


Fig. 2 . . . ANOTHER USE for the safety plug, as explained in the text

Miners are usually careful about tamping the first and second cartridge or stemming too hard for fear of exploding the dynamite, particularly if the cap is placed properly in the charge—namely, in the last stick of powder, with the end containing the detonating charge toward the dynamite. Regardless of how hard the last cartridges are tamped, there is invariably a space left that acts as a cushion when the powder explodes.

The safety factor also should be considered. In case of a misfire the sand or clay cartridges can be blown out with a blowpipe without exploding the charge. The plug can then be withdrawn by the cord and the charge fired with safety. Another advantage is illustrated in Fig. 2, when drilling through hard ribs and encountering open seams. In this case, the plug permits one to confine the explosive in the part to be broken.

Unwatering a Mine With a Deep-Well Turbine Pump

THE MOTOR is being fitted to the top of the pump column. The entire assembly is next bolted to timbers at the collar

Installation proves highly successful in a 200-ft. shaft. The task was accomplished without breakdowns or need of repairs

E. E. Erich
French Gulch, Calif.

THE SINKING PUMP customarily used in mine work has many limitations. Extensions must be inserted in the discharge column and the pump must be lowered, re-connected and started again. To the observer the procedure appears simple, but trouble usually occurs while following the water down with the sinking pump in the confines of the narrow, slippery shaft. For example, the threads of a new length of discharge pipe often refuse to take hold, the pump may not start, the suction pipe may have sprung a leak and the pump will not pick up water, or the power may go off, or there may be other unexpected delays. Meanwhile, slowly but relentlessly the water rises in the shaft and comes lapping around the pump. Then comes frantic tugging on the chain blocks or signal cord to urge hoisting the pump before it, too, is flooded.

Recently, I had another water-filled mine to examine, and again came visions of grim men wrestling with a sinking pump in a water-spouting shaft. The question arose, "Why not try another kind of pumping equipment?"

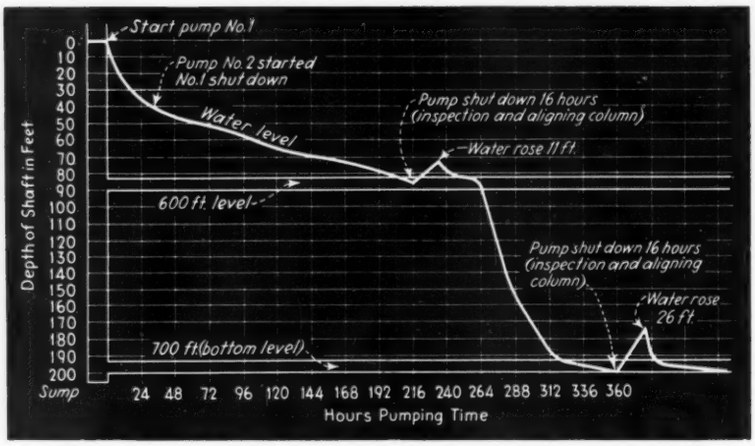
The air lift was out of the question, as it could not be used to complete the unwatering and, moreover, no compressed air was available. Finally, the deep-well turbine pump was investigated. I was well aware that deep-well pumps had a wide use but did not know how effective they were in unwatering mines. Inquiry among engineers brought out expressions such as: "Yes, deep-well pumps have been tried, but they won't work satisfactorily in a mine"; "They have too long a line shaft"; "Too many bearings that can't be watched or kept lined up"; and similar objections. Many reasons were given as to why deep-well pumps are not practicable in a mine.

In spite of these discouraging opinions I looked more thoroughly into the matter. It was found that nearly every pump manufacturer had for sale a deep-well turbine pump, and the selection of a suitable one became as confusing as the purchase of a new automobile. The pumps all looked similar and there appeared to be little difference, even in price. However, upon further inquiry it was found that there was a difference and that there were reasons for the discouraging replies given by the engineers. Apparently, much grief had resulted from the fact that some pumps were ineffective under certain conditions. The chief difficulties appeared to be the lubrication of the bearings and alignment of the long driving shaft. Some pumps were obstructed easily by dirt or sand. Others failed because of faulty drive-shaft assembly.

Our problem was to unwater the mine through an underground shaft 200 ft. deep. The shaft was inclined between 75 and 80 deg. and was reported to have a slight bend about 50 ft. down. Water in a volume of about 100 g.p.m. flowed out of the top of the shaft.

The bend in the shaft appeared to preclude using a single deep-well turbine pump, as it did not seem practicable to insert a straight column containing the drive shaft across the bend. To overcome this difficulty, we at first believed it necessary to install two pumps, one to lower the water to the bend and the other to be installed at the bend and operated from that point.

Inasmuch as the task of unwatering had to be done primarily to permit sampling the flooded workings of the mine, and it was not certain that work would continue after the examination was made, it was believed that the cost of buying two pumps would be excessive. Unwatering with the ordinary sinking pump was therefore reconsidered. Our situation was explained to the equipment representative, who, not intending to lose the sale of one pump or possibly two pumps, offered to sell us the necessary equipment on a conditional sales contract basis which provided that an initial payment on the purchase price of the two pumps be made and with another payment in ninety days, and, thereafter, monthly payments until the total amount was paid. We were



PROGRESS made in unwatering the 200-ft. shaft in 432 hours of pumping time is shown

to have the privilege of returning the pumps at any time prior to the completion of payments, in which event the payments made would apply as rental and we would not be obligated further.

This arrangement was accepted, and two new Pomona deep-well turbine pumps having water-lubricated, hard-rubber, self-aligning bearings and open-shaft columns were selected and installed as follows:

Pump No. 1, driven by a 10-hp. electric motor and having a capacity of 200 g.p.m. when operating under a 50-ft. head, was to be used to the bend in the shaft 50 ft. down. Pump No. 2, driven by a 15-hp. electric motor and having a capacity of 200 g.p.m. when operating under a 200-ft. head, was to be used to pump the remaining water down 150 ft. farther to the bottom of the shaft.

The equipment, complete with sufficient lengths of shafting and column, was delivered to the mine. Installation of pump No. 1 was completed by two men in two days. The procedure was simple. The pump assembly column units, being constructed in 10-ft. lengths, were assembled at the top of the shaft. First came the short suction, then the 10-ft. impeller unit, then the column units containing a section of drive shaft and the two drive-shaft bearings. As each unit was connected, the assembled pump impeller and column were lowered an additional 10-ft. by means of chain blocks attached to column clamps fastened to the outside of the pump column. The complete pump assembly column was in appearance nothing more than a straight 6-in. pipe which readily slid down the manway side of the shaft and only occasionally did the column hang up on the cross timbers or on other obstructions in the shaft. When this did occur, the column was rotated and worked past the obstruction without much difficulty. The lowering procedure was continued until the suction end of the column reached beyond the bend in the shaft and came to rest on the opposite side and could not be lowered further. The 10-hp. driving motor then was fitted on top of the column and the driving shaft (inside of the column) and discharge pipe were connected. The entire unit was bolted down on two timbers placed across the collar of the shaft and the power was turned on. Immediately the pump started to function and discharged water at a greater volume than its rated capacity. This, of course, was due to starting at a zero head. The water level in the shaft dropped rapidly and soon was lowered to the bend in the shaft.

While No. 1 pump was operating, No. 2 column was assembled and started from the collar of the shaft down alongside column No. 1 and extended until it, too, reached the bend and rested there.

When No. 1 pump had lowered the water so that we could go down to the bend, it was found that by slightly springing column No. 2 at this bend, and by cutting into the shaft timbers, it was possible to continue to slide No. 2 pump assembly column past the bend and on down to the bottom, thereby permitting a continuous column extending from the collar to the bottom of the shaft. The 15-hp. driving motor then was fitted on top of the column No. 2 and at this stage of the work the driving shaft and discharge pipe were connected. This second pumping unit was then bolted down at the collar of the shaft alongside pump No. 1.

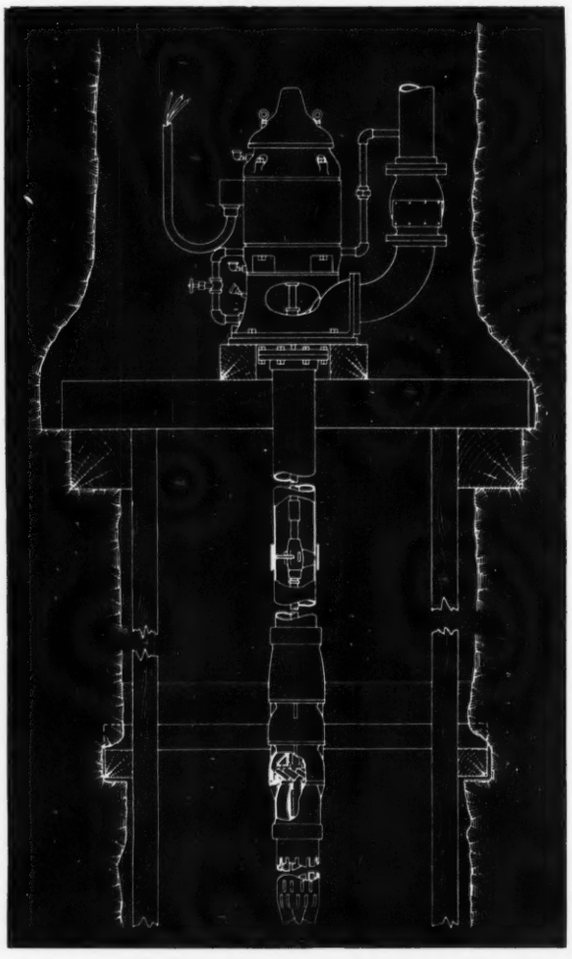
Pump No. 2 was started and No. 1, which had reached its limit and was holding the water at the bend in the shaft, was no longer required. Pump No. 2 began to function and performed in a similar manner as No. 1 when it first started—that is, it discharged much more water than its rated capacity.

Again the water level in the shaft receded. As the water was in this manner being lowered to the bottom of the shaft the volume being discharged gradually decreased to the point that it became the normal capacity of the pump.

The pumps operated quietly. Only a slight hum produced by the electric motors and pump impellers could be heard.

The pump shaft bearings, being water-lubricated and self-aligning, required no attention, and, from the time of starting pump No. 2, no further attention was required for the operation except that for aligning the column and providing a watchman until the water level reached the bot-

THE PUMP and its driving motor, as installed in the shaft



tom of the shaft and the mine was unwatered. The column was aligned to relieve strains that might be on the long drive shaft inside the pump column.

The next problem was to handle the inflowing water so as to permit work on the bottom level. An automatic pump-starting switch to be operated by a float in the sump was considered. This was intended to eliminate the cost of labor for pump men, one for each 8-hr. shift. However, it was found that so long as the pump was kept operating it would automatically handle all the water flowing into the sump and would not lose its priming, even though the water level went below the pump impeller bowls and the pump began to take in air at the suction intake. The reason for this is that the water column above the impellers remains full and because any decrease of water flow at the suction intake is equalized by a similar decrease in outflow at the discharge end. This condition eliminated further attention and expense for labor for the continued operation of the pump, and the mine thus was kept unwatered automatically.

The rapidity and safety and particularly the low labor costs with which it was possible to unwater this mine were a revelation. Furthermore, when the unwatering of the mine was completed, the pump continued its functions and automatically pumped out the inflowing water, thus eliminating further labor costs for pump men.

There were no breakdowns and no repairs were necessary. In the event of a breakdown the pulling of the column could have been accomplished with little effort, and repairs made.

I realize, of course, that there are limitations to every type of pump and conditions where only special types can be used. However, where ordinary unwatering problems are involved and where the mine shaft is not too flat (not less than 70 deg. being recommended), the outstanding advantages of a deep-well, water-lubricated, turbine pump warrant its consideration.

Ingenious Oiler Devised for Stoper Drill

Design worked out in Real del Monte shops at Pachuca

TO OBTAIN proper lubrication of stoper drills, E. W. Everheart, superintendent of shops, devised a small pump-like contrivance to be placed in the feed piston and to be operated by the reciprocating motion of the drill, writes V. A. Brussolo, superintendent of mines, Pachuca district, Cia. de Real del Monte y Pachuca, Mexico. The device is simple in design and entirely automatic. Local experiments showed that about 25 c. c. of oil, when properly applied, is sufficient to lubricate a stoper during an entire shift, with actual operating time at about 3½ hours. Under most adverse conditions it was found that 50 c.c. are necessary.

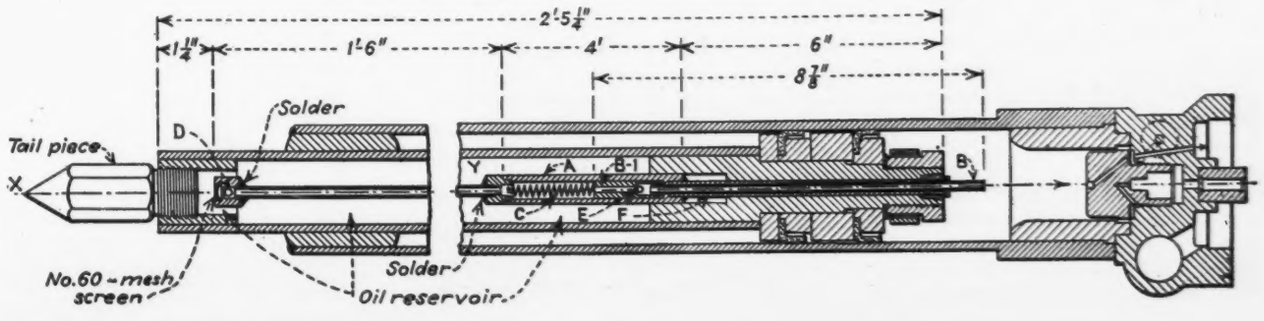
In drill lubrication, given a sufficient quantity of oil, the principal factor is the interval between oiling periods; that is, lubrication must be frequent (within reasonable limits) if a maximum life of drill parts and efficient operation of the drill are to be assured. Despite the fact that the standard line oiler has proved to be a most valuable drill accessory in many instances, at Pachuca, because of some peculiar local conditions, this device was not found satisfactory. In consequence, the Everheart oiler was evolved which oils the drill automatically at short intervals.

The general layout and the oiler parts are explained in the line cut. The feed piston is used as an oil reservoir. It holds roughly 750 c.c. of lubricant, more than sufficient to operate the drill a week, based on a maximum consumption of 50 c.c. per shift. Each feed piston is refilled once a week by a special operator. This is done quickly after removal of the tailpiece. The oil pump proper consists of two parts —namely, the intake and the pump assembly. The intake, comprising a $\frac{5}{8}$ x $\frac{1}{2}$-in. round brass chamber, contains a 60-mesh brass screen to prevent dirt from entering the pump, and a sphere *D* above the screen which acts as a check valve. This unit is soldered to a $\frac{1}{4}$-in. steel tube extending and soldered to the pump assembly proper, which comprises the brass cylinder *A* $\frac{3}{8}$ in. in diameter; steel spring *C*, $\frac{5}{128}$ x $2\frac{5}{16}$ in.; brass piston *B-1*, $\frac{3}{8}$ x $1\frac{5}{8}$ in.; and steel sphere *E* (check valve).

The piston *B-1* is soldered to the $\frac{5}{16}$-in. steel tube *B* with an inside diameter of $\frac{1}{8}$ in., which fits closely inside the $\frac{5}{16}$-in. tube *F*. This unit in turn is soldered to cylinder *A*, with tube *B* protruding about 1 in. beyond the end of tube *F*, which distance controls the stroke of piston *B-1* and consequently the amount of oil fed to the drill. The bushing on the opposite end of tube *F* is made from a pipe plug. The assembled device is placed inside the feed piston in the following manner: After removal of the bushing on the end of tube *F*, the complete unit is slipped into the bottom end of the feed piston until chamber *A* enters an especially provided recess and tube *F* extends beyond the upper end of the feed piston. Next, the bushing is screwed tightly onto the threaded end of tube *F* and the tailpiece screwed back in place.

Operation is relatively simple. As the settling drill telescopes the feed piston, the backhead of the drill pushes down simultaneously tube *B* and piston *B-1*, this operation permitting lubricant to flow through valve *E* and then discharge into the rock drill valve chest as indicated by arrows. When the feed piston is forced out, valve *E* closes and intake valve *D* opens, thus allowing oil in the reservoir to fill the lower end of the pump unit. This cycle is repeated at every up or down movement of the drill feed piston. So far, 150 stoper drills have been fitted with the contrivance, which is patented.

STOPER DRILL, in longitudinal section, showing the oiling device employed



Some Tests With Flotation On Mesabi Wash-ore Tailings

Results indicate that the process is applicable in some cases at least with certain limitations

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Minneapolis, Minn.

MOST of the concentrated ore shipped from Minnesota is obtained from the treatment of wash ores. During 1936 a total of 6,693,102 tons of wash-ore concentrates was shipped from the Mesabi Range. As a general rule we may say that 65 per cent of the feed goes to concentrate and 35 per cent to tails. The estimate is made accordingly that 3,603,978 tons of wash-ore tails was produced with an average iron content of about 22 per cent. Total shipments of iron ore from the Lake Superior district in 1936 amounted to about 45,000,000 tons, compared with 62,500,000 tons in 1937. It seems reasonable to assume, therefore, that about 4,750,000 tons of wash-ore tailings was made in 1937. A great accumulation of this material exists in tailings ponds. Part of this tonnage no doubt is amenable to flotation. However, the problem at hand is the treatment of tailings as they are currently produced.

T. B. Councilman[1] has given a flowsheet covering the treatment of wash ores. It is shown on page 43. The present work indicates that this flowsheet may be extended to include desliming equipment and flotation units.

Wash-ore tailings have desirable characteristics for flotation. There is no mechanical locking of the particles; particles are small in size and in a state suitable for flotation except that in most cases desliming would be necessary. This could be done cheaply by auxiliary apparatus. The cost of mining and handling has been written off, and the cost of producing concentrates would be only the actual cost of the operation itself.

Experimental work on the flotation of iron oxides was started in the Minnesota School of Mines and Metallurgy in the fall of 1930 and has been carried on intermittently up to the present time. During this period much information and knowledge of technique were acquired. Discussion of this development work is omitted in this article.

A number of important facts were learned, and among the most important were those having to do with the water used. We found that hard water, or water containing salts of calcium and magnesium, was very harmful, the reason being that calcium and magnesium soaps were formed which have a tendency to smear everything in the cell indiscriminately and produce conditions under which no concentration can take place. Minneapolis tap water produced this condition, but, when it was run through a water softener of a household type, the results were as good as when using distilled water. Tests have been made on Mesabi Range waters and were found to be satisfactory. Evidently this is due to the fact that no limestone exists in northern Minnesota and the surface waters are free from metallic salts of calcium and magnesium.

A great number of tests were run to determine the best reagents. From the start we decided on an alkaline circuit, and tests of many alkaline substances were made to determine which was the most satisfactory. The conclusion was reached finally that sodium carbonate was the best from the standpoint of results, cost, and availability. Tests of fatty acids were likewise made to determine which one was the most satisfactory. Oleic acid was finally selected as best from the standpoint of cost and availability. Moreover, it is liquid at room temperature.

Desliming was found necessary to produce a good product. Wash-ore tailings carry some very fine material, the amount depending upon the type of wash ore mined. The more "painty" ores contain the most. The fine material consists principally of kaolin together with extremely small particles of silica and hematite. An attempt at flotation without desliming results in a very high reagent consumption and a poor grade of concentrate. In fact, it was found impossible to produce a concentrate of satisfactory grade without desliming. The saving in reagents and the improvement in grade of concentrates produced more than offset the loss of iron due to desliming.

Laboratory Tests — In September, 1937, I made a special trip to the Mesabi Range to collect samples. Three different ones were taken directly from the bowl classifiers. They were deslimed by hand-washing and were treated in a laboratory flotation cell. The results of the tests are given in Tables I to VI.

Sample A was taken by the washing plant foreman under the direction of the plant superintendent. The sample was procured during an 8-hour night run by dipping with a sample bucket from the overflow of the bowl classifier. A certain number of sample buckets were taken for every trainload of wash ore brought to the plant. The sample was placed in a steel barrel and allowed to settle, clear water was decanted off, and the solids were removed.

Sample B was taken the same way as Sample A except that a sample bucketful was taken at regular intervals, the reason being that the feed to this plant came in on a conveyor belt.

Sample D was taken over a period of time by the plant foreman in much the same manner as that in which the previous samples were obtained.

This method of sampling met the approval of companies from which they were procured, being taken in the same manner as their own. In each case the sample represents a run of about eight hours' duration.

Table I shows that the samples have somewhat different characteristics. In Sample A, 6.64 per cent of the total weight is + 150 mesh and contains 10.32 per cent of the total iron. Sample B has 6.38 per cent + 150 mesh and contains 12.71 per cent of the total iron in the sample. Sample D differs from the other two in that only 4.30 per cent is + 150 mesh and contains only 2.89 per cent of the total iron. The sample which subsequently proved best adapted to flotation had a sandy appearance and evidently contained

[1] "Beneficiation of Iron Ores in the Lake Superior District." Birmingham Meeting, A.I.M.E., April, 1937.

less very fine material than either A or B. This fact is not apparent from the screen analysis, the fines no doubt being in the form of kaolin, the individual particles of which are much smaller than the openings of the 325-mesh screen used.

The three samples were deslimed by hand-washing and decanting. This method is rather crude, and the results obtained would probably not compare with those obtained with proper equipment. Table II shows the results of desliming.

The screen analysis of the deslimed samples A, B, and D is given in Table III. It will be noted that some beneficiation has taken place during the process of desliming. Sample A has increased in assay value from 23.84 per cent Fe to 29.83 per cent Fe. Sample B has increased in value from 19.29 per cent Fe to 27.83 per cent Fe. Sample D shows the least increase, changing from 21.76 per cent Fe in the original sample to 23.75 per cent Fe in the deslimed sample. This might be expected, as Sample D contained the least amount of fines which are lower in iron than the coarser sizes.

Table I—Results of Screen Analysis of Samples A, B, and D in Their Original Condition

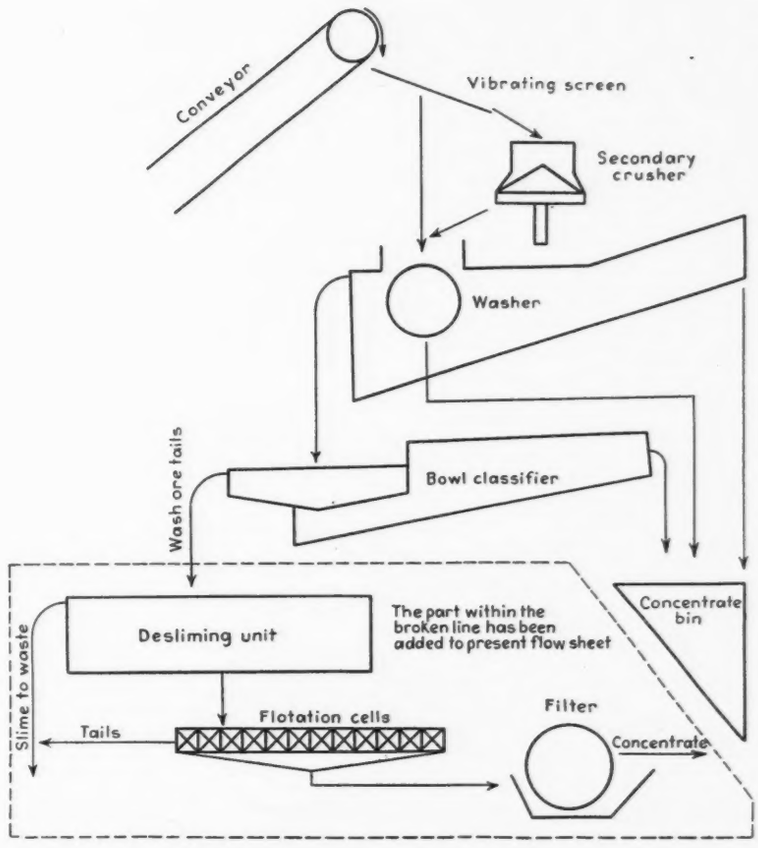
No.	Mesh	% Wt.	% Fe	Units Fe	Dist. Fe
A2	+100	6.64	37.08	2.46	10.32
	+150				
A3	+200	9.64	31.33	3.02	12.66
A4	+270	10.84	25.03	2.71	11.38
A5	+325	6.12	19.16	1.17	4.91
A6	−325	66.76	21.69	14.48	60.72
				23.84	
B2	+100	2.36	39.14	0.92	4.80
B3	+150	4.02	37.84	1.52	7.91
B4	+200	6.00	27.53	1.69	8.52
B5	+270	7.16	19.71	1.41	7.33
B6	+325	5.70	12.79	0.73	3.80
B7	−325	74.76	17.41	13.02	67.65
				19.29	
D7	+100	0.64	18.33	0.12	0.54
D8	+150	3.66	14.00	0.51	2.35
D9	+200	11.90	17.80	2.12	9.73
D10	+270	16.04	23.38	3.75	17.25
D11	+325	5.86	21.01	1.23	5.66
D12	−325	61.90	22.66	14.03	64.48
				21.76	

Table II—Results of Desliming Wash-Ore Tailings

	A	B	D
Weight of original material, kg.	16.650	21.000	15.000
Weight of deslimed material, kg.	7.445	6.035	11.040
Loss in weight, kg.	9.205	14.965	3.960
Loss in weight, %.	55.29	71.26	26.40
Loss in Fe, %.	43.98	58.54	22.49
Assay value of slime, %	18.96	15.85	16.21

Table III—Screen Analyses of Samples A, B, and D After Desliming

No.	Mesh	% Wt.	% Fe	Units Fe	Dist. Fe
A22	+100	4.14	37.70	1.56	5.23
A23	+150	10.34	39.08	4.04	13.55
A24	+200	19.34	35.43	6.85	22.97
A25	+270	23.56	27.91	6.58	22.04
A26	+325	8.26	23.90	1.97	6.62
A27	−325	34.36	25.69	8.83	29.59
				29.83	
B20	+100	10.26	40.52	4.16	14.94
B21	+150	12.80	38.52	4.93	17.71
B22	+200	24.18	29.77	7.20	25.85
B23	+270	45.40	21.73	9.87	35.45
B24	+325	4.88	21.83	1.07	3.83
B25	−325	2.48	24.82	0.62	2.21
				27.83	
D3	+100	1.18	17.51	0.21	0.87
D4	+150	4.32	13.80	0.60	2.51
D5	+200	19.00	19.57	3.72	15.66
D6	+270	17.76	23.07	4.10	17.25
D7	+325	15.50	21.56	3.34	14.07
D8	−325	42.24	27.91	11.79	49.64
				23.75	



FLOWSHEET for treating Mesabi wash ores with desliming and flotation equipment added for recovering the iron now lost in tailings

Flotation Procedure—A 500-gram sample of the deslimed material is placed in a laboratory sub-aërated type of flotation machine. A weighed amount of sodium carbonate is added to the cell and allowed to mix for about ten minutes. At this time oleic acid is added drop by drop until a suitable froth is produced. If the previous steps have been performed properly, a heavily laden froth is produced which will remove the hematite particles from the cell in a short time.

This produces a "rougher" concentrate and a clean tailing. The concentrate is refloated without the addition of more reagents, except that in some cases a small quantity of sodium silicate may be used to break down a stiff froth. This yields a clean concentrate and a middling which contains considerable iron. This product in actual practice would be re-circulated and only clean concentrates and clean tails would be produced. The results of these tests are based on calculations involving clean concentrates and clean tails. A deviation from these results might occur if the middlings in question did not split up into concentrates and tails of the same grade as those produced in the laboratory.

It is evident from Table IV that ore particles larger than 200 mesh did not respond to flotation. The iron content of the +100 mesh material in Sample A decreased from 37.70 per cent in the deslimed material or the flotation feed to only 33.93 in the tails. The plus-150-mesh particles responded somewhat better, the iron decreasing from 39.08 per cent in the feed to 25.75 per cent in the tails. These two coarser sizes contain 63.61 per cent of the total iron present in the tails. The coarser sizes in Sample B also failed to respond. Inasmuch as the two coarser screen fractions were comparatively high in iron, their failure to float had a marked effect upon the recovery. In this sample the plus-200-mesh material contained 65.9 per cent of the total iron in the tails.

Sample D differed from the other two in several important respects. The flotation feed contained a smaller amount of the two coarse sizes and their iron content was lower (see Table III). In this sample only 5.50 per cent of the flotation feed was coarser than 200 mesh, compared with 14.48 per cent for Sample A and 23.06

The Amplifier

A New Item of Mine Equipment

Device is found useful for safety meetings and campaigns

T. G. Murdock
Safety Engineer
Minas de Matahambre, Matahambre, Cuba

THE mine operating official, or safety engineer, who is frequently faced with the duty of addressing a group of mine workmen, will be interested in learning of an application of amplifying equipment made by Minas de Matahambre, in Cuba, for this purpose. At its underground copper mine in Pinar del Río Province the company has in progress an intensive safety campaign. The usual safety committees were organized and functioned well; the use of safety posters, service buttons, and strict enforcement of safety rules, together with recognition of safety as an operating problem by the management and staff, produced results. However, it was found that something more was needed to reach every workman with a special personal appeal to work safely and be careful; and some workmen needed special instruction in the safe manner of working.

Speeches at the collars of the shafts to the shift going down were suggested and the suggestion was carried out. Some improvement was noted, but still a complete response was lacking and the few speakers available had difficulty in maintaining the undivided and continuous attention of the listeners, competing as they had to do with the distraction caused by late arrivals. So it was decided that the individuals who were bashful about coming near would be able to hear if loud-speaking equipment were used. In fact, they could not avoid doing so. The innovation would have the additional advantage that it would turn to account the popularity of the radio, as most of the workmen were already radio-minded.

Accordingly, the available equipment

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per cent for Sample B. The plus-100-mesh particles in Sample D contained only 17.51 per cent iron, compared with 37.70 per cent for Sample A and 40.52 per cent for Sample B. Similarly, the plus-150-mesh particles in Sample D contained only 13.8 per cent iron, compared with 39.08 per cent for Sample A and 38.52 per cent for Sample B. Due to the combined effect of the smaller amount of plus-200-mesh material in Sample D, and the low iron content, the two coarser sizes contained only 3.38 per cent of the total iron in the feed. It is evident that the amount and iron content of particles larger than 200 mesh which do not respond readily to flotation have a pronounced effect upon recovery.

The recovery by flotation and the over-all recovery including the deslimming treatment are summarized in Table V.

The best results were obtained on Sample D, which contained the smallest amount of iron in the coarser sizes. This sample not only gave the highest recovery but the concentrates were higher in iron and lower in silica.

Grade of Concentrates — Results obtained are of particular interest because in all cases a merchantable grade of concentrates was produced, as shown by a partial analysis given in Table VI.

The iron content of the concentrates produced is in all cases well over the base ore of 51.5 per cent iron. The silica is under 10 per cent and accordingly escapes penalty. Alumina is low, as might be expected. It would be necessary to agglomerate the concentrates which are exceedingly fine.

Table IV—Screen Analyses of the Tails From Samples A and B

No.	Mesh	% Wt.	% Fe	Units Fe	Dist. Fe
A30	+100	6.40	33.93	2.17	25.75
A31	+150	12.40	25.75	3.19	37.86
A32	+200	18.73	9.16	1.72	20.34
A33	+270	22.35	2.92	0.65	7.74
A34	+325	13.46	1.54	0.21	2.46
A35	−325	26.66	1.85	0.49	5.85
				8.43	
B26	+100	13.60	33.37	4.54	33.06
B27	+150	17.13	26.31	4.51	32.84
B28	+200	24.33	13.08	3.18	23.18
B29	+270	16.67	4.43	0.74	5.38
B30	+325	13.13	2.52	0.34	2.47
B31	−325	15.14	2.78	0.42	3.07
				13.73	

TableV—Summary of Recovery, Per Cent

Recovery	Sample A	Sample B	Sample D
Weight recovery by flotation	40.69	31.28	28.69
Over-all recovery by weight	18.20	8.98	21.12
Recovery of iron by flotation	83.24	66.09	93.16
Over-all recovery of iron	46.63	27.40	72.20

Table VI—Partial Analyses of Concentrates, Per Cent

Sample No.	Fe	SiO_2	Al_2O_3
A29	61.02	8.84	Trace
B14	58.81	9.52	Trace
D6	63.44	5.71	Trace

Summary of Results

Although the results on only three samples are reported here, the present study, together with previous tests, indicates that wash-ore tailings are amenable to flotation. It is necessary, however, to use water that is low in calcium and magnesium. The degree of floatability depends primarily upon the amount and iron content of material coarser than 200 mesh. It is evident that wash-ore tailings vary widely in this respect and would respond very differently. It seems reasonable to assume that a substantial part of the large tonnage of material in existing tailing ponds is amenable to flotation.

I wish to acknowledge the assistance and encouragement of T. L. Joseph, professor of metallurgy.

was studied and an R.C.A. Victor portable public address system, Type PG-98, was purchased. As described in the instruction sheet that comes with it, this equipment is a complete amplifying system, comprising an amplifier, a microphone and a desk-type stand, two loud-speakers, and the necessary cables for the hook-up. It is quite compact, being contained in a single case. The system is operated entirely by alternating current. Power may be taken from any 50- or 60-cycle, 110- to 120-volt service connection. Power consumption—a.c.—is approximately 165 watts. The frequency range of the amplifier is from 50 to 10,000 cycles; the over-all gain is 110 db., and the undistorted audio output is 12 watts.

The equipment case consists of a sturdy box, cut diagonally, the lower half forming the bottom and the upper half the cover. In this case the upper half is further divided vertically into two sections. In the lower half are the amplifier, the microphone and stand, and the interconnecting portable cables. In each of the two sections forming the upper half or cover is mounted the loud-speaker.

Simplicity marks the operation of the equipment. It is merely necessary to plug the power cord into an appropriate power receptacle, connect the microphone and the loud-speakers to the amplifier by the cables, turn on the power switch of the amplifier, and turn the volume and tone controls to the position which gives clearest and best reproduction.

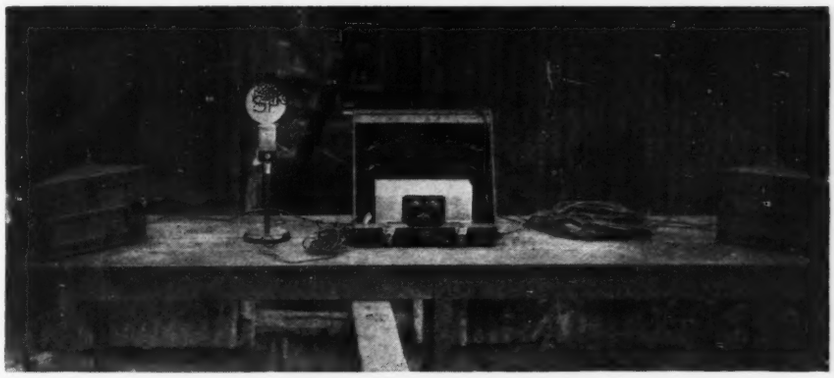
In the installation at the mine the two loud-speakers are placed on shelves outside the mine office, which is close to No. 1 shaft, and the amplifier is in a small room inside the office. The 30 ft. of cable between microphone and amplifier permit the speaker to go outside into the yard where the men are, if he wishes them to see him, or, if he desires, to coordinate his talk with a demonstration being made by another person of the proper manner of wielding a sledge, holding a bar, or re-railing a car. If the speaker is inside the building he can read a prepared speech. This averts the possibility of stage fright and his hearers will probably not know the difference.

The apparatus has proved popular —so much so that when the day shift comes off the men often wait to hear the program that is being given for the afternoon shift then going on, although they may have already heard it at the beginning of their own shift. Some of them even give talks or read a prepared address. In this way they are beginning to realize that it is their campaign against accidents and that they are the ones who benefit most by having a clean record. The program is made as attractive as possible and there are even musical numbers, with parodies on their favorite songs, carrying a safety message. There is an announcer who functions in much the same way as does an announcer for a regular radio program. He calls the station "S.P.," for *"Seguridad Primero,"* the local Spanish equivalent for "Safety First," and makes parodies of the advertisements of local radio stations, each with a safety slogan.

This amplifying equipment also works well in an auditorium and has been used in showing safety films with English titles, as the speaker could translate the titles into Spanish and comment on desirable portions of the film and their application to local conditions.

A 16-mm. home movie outfit is also in use to demonstrate on the screen the safe way of doing a job. This is another feature of the safety campaign which is popular with the workmen.

Other uses of the apparatus around a mine suggest themselves: For instance, in some phase of a construction or repair job where it may be necessary to coordinate the work of several crews of workmen, each at some distance from the other. This could well be done by command of a single person speaking into the microphone. One-way communication with adjacent buildings would be a simple matter with the use of the equipment. Although it has not been tried, it is believed that this could also be provided for shallow shafts and short tunnels in the same way.



THE EQUIPMENT, connected up, is seen in the upper picture. At the right and left are the two loud-speakers, with the microphone and the amplifier in the center. The lower photograph shows workmen at a demonstration. Some of them look at the demonstrator, others at the camera, but all of them listen

ONE MAN carries the outfit easily. Note the "clock" in the background which shows two months and 23 days without a lost-time accident

When Planning
To Diamond Drill

If the equipment be lacking, should one rent it, buy it, or contract for the work?

Walter Sack
Metaline Falls, Wash.

CONDITIONS that call for core drilling are hardly ever exactly the same as to details in two operations, but, in general, the factors present themselves that determine whether the mining company should do the work with its own equipment; or should undertake it with rented equipment; or should have its drilling done on contract. These factors are best illustrated in examples that show clearly why it was preferable in one case to purchase equipment, to rent it in another, and in still another to have the work done on contract.

In the first case, the purpose of the drilling was to prospect thoroughly a large area to ascertain the general course of an extensive but badly faulted lead-zinc deposit. The geological conditions of this district, in northeastern Washington, required that the holes be closely grouped, compelling the mining company to drill a large amount of footage entirely from the surface. The footage most needed in order to carry on efficient mining and development work totaled 50,000. The lowest bid received from contractors was $3 per foot drilled, with additional costs for standpiping, reaming, cementing, drilling out cement, running casings, and similar operations, all of which, when averaged, brought the contract price to $3.85. At that price the cost of the 50,000 ft. of drilling would have been $192,500. In addition, the mine was asked to furnish labor for clearing the heavily-timbered drill sites and to stand the expense of piping water to the rigs.

With these facts in hand, the mining company investigated whether it would be more economical to do the work itself. It considered the renting of two surface rigs with standpiping equipment and other necessary apparatus for holes 800 ft. deep. Rental for this was found to be $700 per month, with the mine carrying the cost of keeping the machines in repair and replacing all worn, used-up, damaged, and lost equipment.

Total rental for the rigs and equipment for 50,000 ft. of drilling was calculated on the basis of the average footage drilled per 24 hours in 75 work-shifts, or one month, on other drilling jobs in the same district. The average footage for one machine was 35 ft. per 24 hours, or 875 ft. in one month. That, of course, included moving and setting up, reaming, running casing, and cementing. At that rate, it would have taken two rigs 28 months to drill 50,000 ft. at a rental of 28 times $700 or $19,600. This, figured per foot ($19,600 divided by 50,000) came to $0.39 per foot. All other cost data, necessary to arrive at the price per foot on the intended rental work, were carefully gathered from cost averages for jobs that had been carried out in similar ground. The items in Table I were brought together, giving a total of $2.05 per foot.

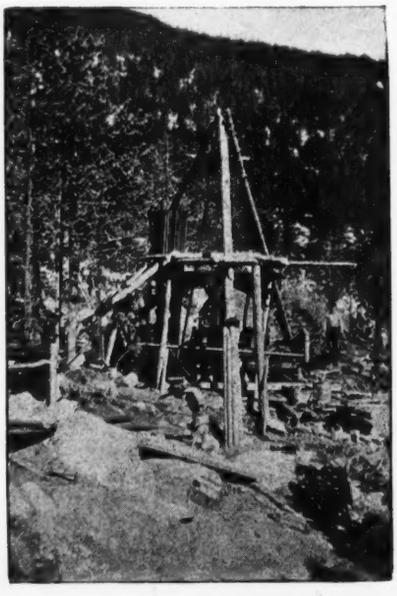
Even though the price per foot with rented equipment was much lower than the contract price, it was not accepted, because the rent of the equipment on 50,000 ft. was more than the actual purchase price. That meant that it was more economical to purchase the equipment and let it earn the amount expended. Thus the cost per foot would be lowered from the start; and as soon as the equipment was earned, the cost per foot would be even lower. Then the additional drilling which was foreseen could be carried out with the same equipment, at a very low cost. The mine, moreover, would have the benefit of the $0.06 per foot allowed for repairs and replacements because this upkeep would be applied on its own rigs instead of on rented ones.

The purchase price for the two surface rigs with all the equipment for standpiping and for drilling holes 800 ft. deep, including pumping and other operations, was $12,000. That sum divided by 50,000 ft. of hole is $0.24 per foot. The other costs remained the same and were added to the purchase price, as itemized in Table II. However, the actual average cost per foot was slightly lower than $1.90 because of a smaller cost for diamonds than that given.

During the course of development work in the same mine, the geological conditions have called for continuous underground drilling. This work, also, is being carried out with mine-owned equipment. The cost of the underground work is much lower than that of the work carried out on the surface by this company because of the elimination of standpiping work underground. Although the purchase price of the underground equipment was still charged against the footage, the average was as low as $1.38 per foot.

The case in which it was preferable to rent equipment was that of a drilling job undertaken for the purpose of proving the tonnage and value of a known extensive gold orebody of low grade, in western Montana. Much of the ore was already blocked out by old mine workings, and the unknown portion of the deposit could best be tested from underground. Conditions, however, were such that no certain footage could be foreseen exactly. A few short holes might call for additional footage or prove further drilling useless. Yet, consideration was first given to purchasing the equipment and undertaking the work this way; but after more thorough investigation the company officials decided that, be-

A SET-UP on a vertical hole



cause of the uncertainty of the footage required and because they were not likely to need their own equipment in the future, it was not sound economy to invest in equipment that might never have a chance to pay for itself. They thought it best to have the work done on contract.

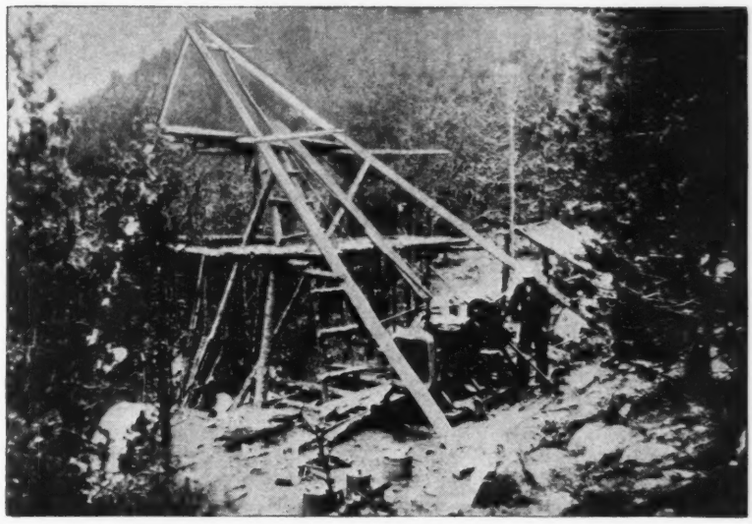
Drilling of four holes, each 500 ft. deep, was decided upon as the initial footage. The lowest bid on this 2,000 ft. was $2.60, with the mining company paying the freight both ways on the equipment and also furnishing the compressed-air power, including pipe lines for air and water. All the other cost added to the actual drilling price brought the per-foot cost much higher, as Table III shows.

The price given, $3.96, was thought too high, especially in case the footage to be drilled should run several times 2,000 ft., as was possible. Also, the mining company had to pay the freight on the equipment, and it had to furnish the power and pay for the hauling and maintenance of the compressor; and supply the air and the water line, and install them. The cost of all this covered one-third of the contract price. No doubt, well within the other two-thirds should lie the rent for drill equipment, the cost of running it, and the cost of diamonds. This led to a thorough investigation of the matter of renting. Rental of a light underground machine with equipment for holes 500 ft. deep was $225 per month. The cost per foot was calculated for three months on 2,000 ft., as given in Table IV.

One must remember that $3.19, given in Table IV, was the estimated price per foot on 2,000 ft. The total footage ran 9,000 ft. in nine months, at a cost of $21,891.75, or an average of $2.43 per foot. The diamond cost ran much higher than estimated; but, on the other hand, there were savings in the fuel for the compressor. Another great cut in the cost per foot was achieved in using ready-set bits, eliminating the cost of setting the diamond bits on the job, and that of keeping a surplus stock of diamonds.

In the third case, a drilling job for the purpose of cutting and sampling a vein at 250 ft. and 500 ft., respectively, below the present sump of a silver-lead mine in the Coeur d'Alenes, Idaho, preliminary to sinking a winze, it was preferable to contract the drilling. The footage was definitely known to be 1,700 ft., in two short and two longer angle holes.

Geological conditions in this mine are so uniform that no drilling is required along with the routine mining; and whenever the need arises for drilling, which is very seldom, the footage is always definitely known and so limited that it hardly pays to buy equipment for the work. The drilling



A DIAMOND-DRILL SET-UP on a 45-deg. hole in northeastern Washington

discussed here involved the largest footage of any ever carried out in the mine. It was a special occasion which probably would arise again only in many years. For such a special occasion it was not economical to buy equipment.

However, rental was considered but had to be rejected because conditions were such that the rig could be worked on one shift only in 24 hours. At this rate, the average progress of 12 ft. per shift with 25 shifts per month would stretch the job over a period of five months. At a rent of $250 per month, this would increase the cost per foot considerably. The estimate of cost is given in Table V.

There was the possibility, as proved in other cases, that the actual cost would run lower than the estimated price per foot. It was a gamble. The contract price already was lower than the rental estimate, being $2.25 per foot, with no additions save for power. The logical thing was to have the work done on contract.

As may be seen from these examples, each of the three ways in which diamond core drilling can be done has its definite place, economy being the deciding consideration.

Table I—Cost of Drilling, Using Rented Equipment

Rent for equipment, per foot	$0.39
Upkeep of equipment, per foot	0.06
Cost of diamonds, per foot	0.50
Complete running expense, per foot	1.10
Total, per foot	2.05

Table II—Cost of Drilling With Purchased Equipment

Purchase price, per foot	$0.24
Upkeep of equipment, per foot	0.06
Cost of diamonds, per foot	0.50
Complete running cost, per foot	1.10
Total per foot, average	1.90

Table III—Cost of Drilling Under Contract

	Total	Per Foot
Contract cost on 2,000 ft.	$5,200	$2.60
Freight and hauling of equipment, both ways	260	0.13
Rent on portable compressor, including hauling both ways	410	0.20
Fuel and maintenance (one man) at three months, including pipelines for air and water	2,063.50	1.03
Actual price per foot		3.96

Table IV—Cost of Drilling With Rented Equipment in Second Case

	Total	Per Foot
Rent on drill equipment for three months	$675	$0.34
Upkeep of equipment	40	0.02
Freight and hauling of drill equipment, both ways	260	0.13
Rent on portable compressor, three months	300	0.11
Hauling of portable compressor, both ways, including cost of pipe lines	110	0.05
Fuel and maintenance (one man)	2,063.50	1.03
Labor for drill crew	2,418.75	1.21
Diamond cost	600.00	0.30
Average price per foot		3.19

Table V—Cost of Drilling With Rented Equipment in Third Case

	Total	Per Foot
Rent for equipment, five months	$1,250	$0.74
Freight and other costs	170	0.10
Upkeep of equipment	51	0.03
Labor, 125 work-shifts	1,500	0.89
Power, compressed air from the mine system	34	0.02
Diamond cost	850	0.50
Estimated rental price per foot	$2.28	

Lithium in New England

Spodumene-bearing Pegmatites, Long Known in Various Localities, Are Likely To Become Productive as Demand Improves

Frank L. Hess
Principal Mineralogist
Oliver C. Ralston
Chief Engineer, Nonmetals Division
United States Bureau of Mines
College Park, Maryland

SINCE the spodumene deposits near Kings Mountain and Lincolnton, North Carolina, were described in these pages,[1] spodumene has been like the weather—it has been discussed a great deal, but no one seems to have done much about it. However, things are not always what they seem, and real steps toward a market are being taken. To have information on hand for problems in beneficiation and to supplement data on the southeastern deposits, a number of the New England spodumene-bearing pegmatites were visited.

Spodumene and other lithium minerals have been known in various New England States for many years, and occurrences were long since cataloged by those master mineralogists, the Danas,[2] but so far as known the only commercial shipments have been a carload of lepidolite from Mount Mica, near Paris, Me., and one shipment of spodumene from Warren, Me. The lepidolite had been saved through a number of years in working the pegmatite for gem tourmaline and feldspar and was shipped not for its lithium but for its cesium and rubidium content.

In the town of Newry, Me., 7 miles south of Andover, a pegmatite worked a few years ago for pollucite carries pyramidally terminated spodumene crystals that reach a length of 10 ft., with a cross-section 8 x 13 in.; but the crystals are few, and although they are accompanied by a little amblygonite and lepidolite, the deposit is not rich enough to tempt exploitation for lithium.

As in most spodumene-bearing pegmatites, the spodumene is a late mineral, though albite (here of the cleavelandite variety) is later and replaces most other minerals. Smaller quantities of spodumene, amblygonite, and lepidolite are found in other pegmatites in the same hill.

There are a few other other small spodumene deposits in Maine, but so far as known only the deposit at Warren promises to be of any possible economic value. This deposit is in the woods 100 yards east of the road and a half-mile south of South Warren. As exposed it is a pegmatite about 50 ft. across and has been dug out 4 to 7 ft. deep around the edges and somewhat deeper in the middle, but the lower part was filled with water and could not be examined. It is inclosed in a rather coarse quartz-biotite schist.

Outside of the excavation no pegmatite is visible, except on the west side, where it is in contact with aplite, and on the south, where the rock is covered with soil a few feet from the excavation, but it seems possible that the pegmatite may extend in that direction. However, the uppermost 3 or 4 ft. shows little or no spodumene.

Accompanying minerals are quartz, some mica, microcline and albite, and some black tourmaline. The rock is somewhat stained by iron and manganese. The occurrence is reminiscent of the North Carolina deposits and appears to carry nearly or quite the same percentage of spodumene—say 15 per cent. This, however, is only an estimate based on the appearance of the rock. In the mass as exposed the tonnage is not large. Some of the spodumene is altered to a fine-grained mass of muscovite and albite.

In Massachusetts spodumene has been listed at Goshen, Chesterfield, Chester, Huntington, and Sterling. The deposits noted as at Goshen are nearer the post office of Lithia, a house set in a small triangle formed by three roads, 2½ miles northwest of the village of Goshen. Both places are on U. S. Route 9.

One pegmatite lies a mile north on the Alvin Barrus farm near the top of the northwest side of the deep, rocky ravine cut by Stones Brook. As exposed it is about 3 to 4 ft. thick and 30 ft. long, and follows the schistosity of a lead-gray sericite schist with small knots formed by biotite mica with its cleavage across that of the schist. The strike is a few degrees east of north and the

SPODUMENE PEGMATITE boulder of large size, south of Leominster, Mass.

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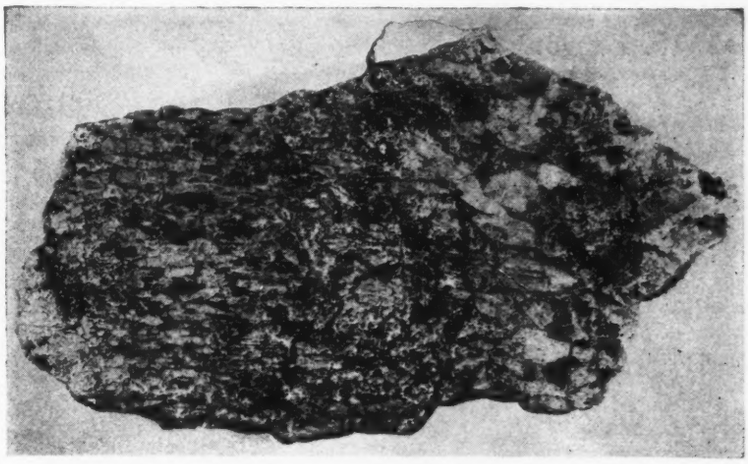
[1] *Eng. & Min. Jour.* Vol. 137, July, 1936, pp. 339–342.

[2] Manual of Mineralogy, 6th Edition, 1892, p. 368.

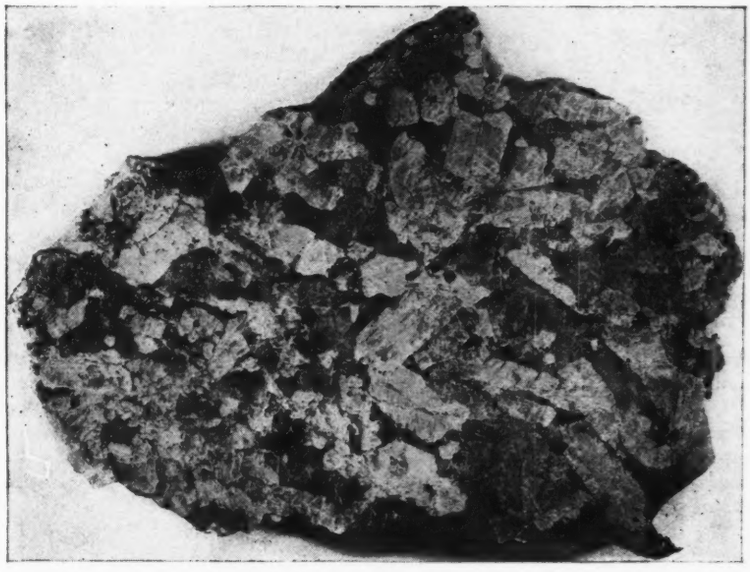
dip is approximately 45 deg. easterly.

The pegmatite is white with a little manganese staining and is of moderate grain with quartz masses reaching 4 to 6 in. across. It is so heavily covered with lichens that where not freshly broken little can be seen of its character.

At the south end the pegmatite contains many long, narrow crystals of spodumene ½ in. to 1 in. thick and 4 to 8 in. long, lying about parallel to the walls and strike. In general, the crystals are dull greenish yellow, though some are white. A few are rather distinctly green and more or less glassy.



A POLISHED SLAB of spodumene pegmatite from Lithia, Mass. It is 11x20 in. in dimensions. The light-gray and white crystals are spodumene, in a quartz groundmass



ANOTHER SLAB, polished, of spodumene pegmatite. It comes from the vicinity of Leominster, Mass., and is 11 in. by 15 in. in size. The light-gray crystals are spodumene and the groundmass is quartz

There are many blue tourmalines a fraction of an inch thick and 2 or 3 in. long; in places these pierce the spodumene as well as other minerals. Others are greenish. A little columbite and cassiterite are found in very small crystals.

Here and there are clear, glassy, cracked minerals as large as the end of one's thumb. They appear colorless but in good light may show a faint green tint. These are goshenite, the colorless beryl. There is also some light yellow beryl, both near the walls and through the middle of the pegmatite. A hundred feet north is a similar pegmatite 20 ft. long with spodumene crystals perpendicular to the wall.

Boulders found in a small branch ravine carry a little pink tourmaline and a pink muscovite which carries a little lithia.[3] On the same farm another white pegmatite is reached by a graveled road which leaves Route 9 a half mile east of Lithia postoffice. The pegmatite is on the west side of the road and three-fourths of a mile from Route 9. It forms the apex of a small hill, above which it stands 10 to 15 ft. It is 10 to 20 ft. wide and 200 ft. long and appears to be rather quartzose. It was visited on a dark, rainy day, and the weather, with heavy shade and thick lichens, made the recognition of minerals difficult. Masses of white microcline were 8 to 10 in. or possibly more in diameter and white mica plates reached an inch across. Near the walls scattered decayed garnets less than one-fourth inch in diameter have furnished manganese oxide to stain the pegmatite somewhat. Blue tourmaline is present, seemingly in less quantity than in the smaller pegmatites. Yellowish white spodumene forms pencils ½ in. thick by 8 in. long and blades 4 in. wide and a foot long, some of which are less than ¼ in. thick. Some crystals are altered to a silky mixture of mica, albite, and quartz, the so-called cymatolite. In places spodumene forms 20 to 30 per cent of the mass; in other places little or none could be seen and no adequate idea of the general tenor of the pegmatite could be obtained.

This seems to be the pegmatite from which originated the spodumene- and "cymatolite"-bearing boulders in which Julien obtained specimens[4] sixty years ago. His analysis showed 6.89 per cent Li_2O in the spodumene.

The spodumene found in the town of Sterling was in white glacial boulders of pegmatite, one of which, 2 miles south of Leominster, is about 15 ft. by 15 ft. by 30 ft. and contains thin, bladed crystals 6 in. broad and several feet long, but most crystals are lath-shaped and not more than a few inches long. No spodumene was visible in about one-third of the boulder.

The boulders are scattered for 5 miles in a north-south line. Recently the source was discovered by Roscoe J. Whitney, of Leominster, at the north end of the boulder train in a series of lenses running about north-south and inclosed in a gray sericite schist which in places contains pink andalusite crystals largely changed to mica and in other places some graphite. Specimens of the pegmatite could not be told from those originating at Lithia. It contains some amblygonite, a little goshenite and a little pollucite (cesium-aluminum silicate). Whitney also reports having found flakes of autunite and torbernite and a little cassiterite, columbite and uraninite.

The largest lenses are 20 to 30 ft. wide and somewhat longer than wide. Some of the lenses, especially near the north end, carry less spodumene than others.

Besides the deposits in Maine and Massachusetts small deposits are known at Branchville and Portland, in Connecticut.

[3] Mallet, J. W.: "On the Rose-Colored Mica of Goshen, Massachusetts." A. J. S. S II, V. 23, 1857, p. 180.

[4] Julien, Alexis A.: "On Spodumene and Its Alterations From the Granite Veins of Hampshire County, Mass." New York Acad. Sci. Ann. V. 1, 1878, p. 319 et al.

Sphalerite—A Study

An inquiry into the relationship between the state of this mineral in aqueous suspension and its flotation

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THE STUDIES of sphalerite outlined in this paper were for the most part conducted simultaneously with those on quartz reported previously.[1] The objectives of the research and the general technique employed were the same as those outlined in the article to which reference is made.

Sphalerite forms a crystal composed of equal numbers of atoms of zinc and sulphur. The lattice, Fig. 1, is the face-centered cube (Bragg: "Introduction to Crystal Structures," p. 68). When crushed, sphalerite does not break perfectly, if at all, on atomic or cleavage planes. This is clearly shown in Figs. 2-a, 2-b, and 2-c, which are photomicrographs of 48/65-, 100/150-, and 200/325-mesh sphalerite respectively.

Unfortunately, in this work the supply of sphalerite initially provided proved insufficient for the duration of the study. Sphalerites of different species, therefore, have been employed. It was found, however, that the sedimentation curves, and for that matter the flotation recovery curves for the various sphalerites, had the same general characteristics.

The sphalerite employed in the initial experiments was a clean, rosin-jack variety obtained from a local prospect mine. Clean, large crystals of the mineral were broken and comminuted with water in a porcelain pebble mill. The carefully dried sample, 75 per cent of which was fine enough to pass a 400-mesh (38-micron) sieve, was stored in a stoppered bottle for use as needed.

The research to be recorded had two principal objectives. The first was to obtain sphalerite-water sedimentation curves for a number of different solutes at various molar concentrations. A sedimentation curve is obtained by plotting stability of the suspension (per cent remaining in suspension at the end of a definite time period) on the ordinate against molar concentration of the reagent (in millimols per liter) on the abscissa. The second objective was to obtain flotation data—*i.e.*, per cent recovery of sphalerite for each molar concentration for each solute used. The object, of course, was to correlate floatability and state of stability (degree of dispersion), and, if possible, by inference and deduction to work out the chemistry involved.

Part I. Sedimentation Experiments and Data—The data from which these sedimentation curves were made up (Table I) were obtained by the siphon

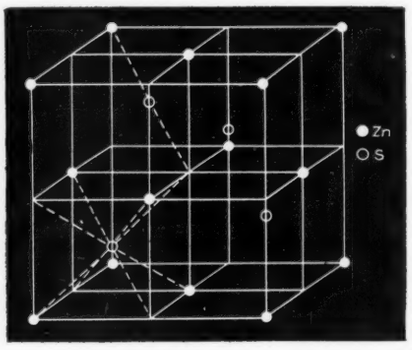


Fig. 1 . . . SPHALERITE forms a crystal composed of equal numbers of atoms of zinc and sulphur. The lattice, here shown, is the face-centered cube

method already described.[1] Data of Part I are not accompanied by flotation recovery curves. A new set of sedimentation curves on another sphalerite sample and the corresponding flotation data will follow in Part II. A discussion of the probable surface reactions involved to account for the state of sphalerite suspension is now offered.

In Figs. 3 and 3-a are given graphically sedimentation curves for a group of weak acid sodium salts (it was assumed that KCN would show the same general behavior as NaCN), including Na_2CO_3, KCN, NaH_2PO_4, Na_2HPO_4, $Na_2Si_4O_9$, and Na_2S; for NaOH; for $CuSO_4$; for $ZnSO_4$, and for hydrochloric acid. This group of reagents is selected mainly because of their usefulness and importance in flotation practice.

Distilled water, having a pH of 6.6, stored in a large glass carboy, was used in all tests. The pH of the water invariably was increased about 0.2 unit upon agitation with the mineral. This fact probably indicates removal in some way of dissolved carbonic acid.

Fig. 3-a embodies settling curves for the same reagents—the increment of solute concentration variation was much smaller—the greatest concentration being 1.4 millimols per liter. The purpose of these data was to analyze more closely the more critical initial parts of the settling curves.

Sphalerite-Water Suspension—The stability of sphalerite in water is indicated by the horizontal dashed line just below the ordinate 10. The position of this line as related to other settling curves on Figs. 3 and 3-a indicates that sphalerite is relatively little ionized in distilled water. C. R. Ince[2] found that sphalerite is anionic in water—*i.e.*, negatively charged. Taggart, Taylor, and Knoll[3] observed microscopically that sphalerite "was not in motion in distilled water," meaning presumably that it was unionized.

These same authors also found that when sphalerite is shaken with water, the water becomes slightly acidic (pH=6.33) and the water gives a strong test for sulphate (with acidified $BaCl_2$). They conclude that sphalerite ground in air has a surface largely $ZnSO_4$ and ZnS_mO_n $(n/m<4)$. Christmann,[4] it would seem, assumes that sphalerite in water is cationic—*i.e.*, positively charged. R. S. Dean, J. Bruce Clemmer, and S. R. B. Cook[5] state, ". . . pure galena and blende are practically neutral, with only slight negative charge."

Our settling curves lead us to believe that sphalerite is only weakly ionized in distilled water, and we are not sure if the particles are cationic or anionic. (Cataphoretic measurements on flocculated minerals are very diffi-

* Laboratory contributions by H. Gordon Poole and Robert H. Raring, Research Fellows, 1931–32 and 1932–33, respectively, Idaho Bureau of Mines and Geology; also by Donald Ingvoldstad and E. Maurice Walters, Research Fellows, 1934–35 and 1936–37 respectively, U. S. Bureau of Mines.

[1] Fahrenwald, A. W., and Newton, Joseph: "Measuring Settling Rates of Mineral Suspensions." *Eng. and Min. Jour.*, Jan., 1937.

[2] "A Study of Differential Flotation." A.I.M.E. Tech. Pub. No. 195, 1929.

[3] "Chemical Reactions in Flotation." A.I.M.E. Tech. Pub. No. 312, 1930.

[4] "Chemistry and the Flotation Process." American Cyanamid Company, Tech. Paper No. 17, p. 11.

[5] U. S. Bureau of Mines, R. I. Serial No. 3333, Feb., 1937, p. 13.

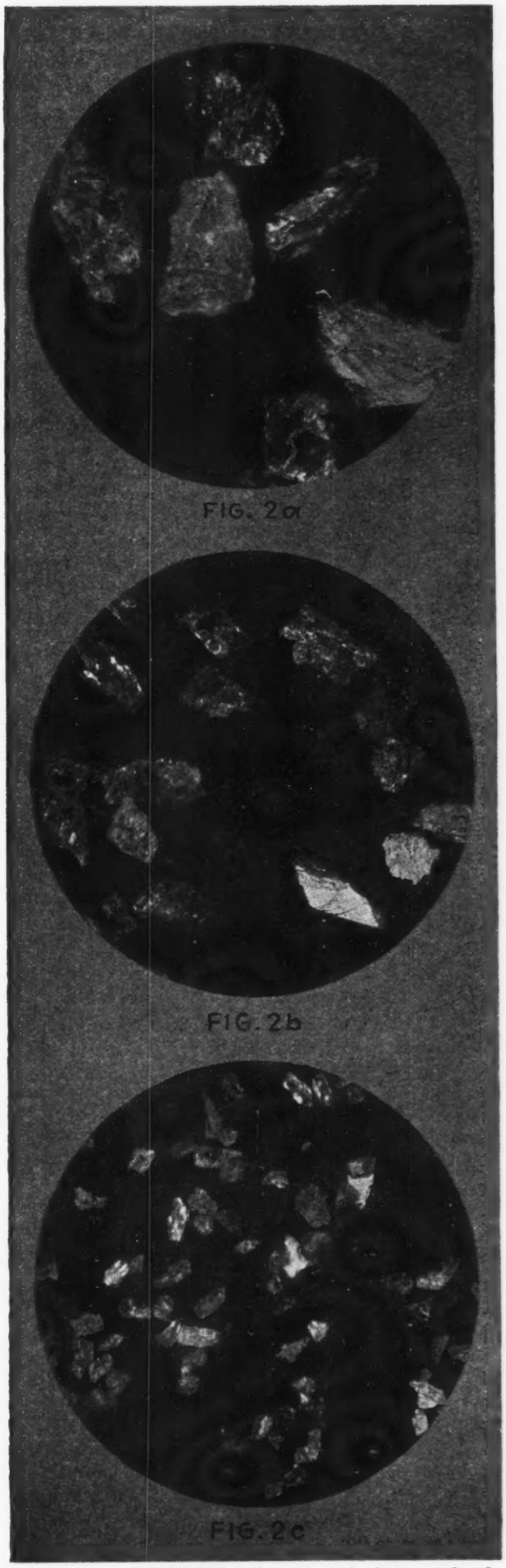


Fig. 2 . . . SPHALERITE, when crushed, does not break perfectly, if at all, on atomic or cleavage planes, as indicated above. Fig. 2a shows 48/65-mesh material; Fig. 2b, 100/150-mesh, and Fig. 2c, 200/325-mesh

cult to make.) There is also the important question of the degree of ionization as related to particle size. Here nothing is known. There is also the question of the extent and relative degree of ionization at flat surfaces, at surfaces of high curvature, and at edges and points. Particles of different shape characteristics and of different sizes, therefore, might be expected to have different flotation properties. Such appears to be the case. A sphalerite suspension in water (the sphalerite having been dry-ground), then, actually is a suspension in water in which zinc sulphate is the solute. Since the sulphate radical has little dispersing capacity, due to complete ionization of sulphuric acid, dispersion of sphalerite is not expected. The solubility characteristics of some of the weakly soluble zinc salts (all salts of weak acids) are given in Table II. It is interesting to note that the cyanide and the arsenate are soluble in excess of the reagents, which, in small amounts, caused them to precipitate. The strong acid salts (Anions Cl^-, SO_4^{--}, NO_3^-) of sodium are highly soluble. It is doubtful, in small concentrations, if they exercise any direct influence in sedimentation.

Zinc Sulphate, $ZnSO_4$.—It may be seen from Fig. 3 that zinc sulphate disturbs only slightly the sedimentation rate of sphalerite in water. The sedimentation curve has a slow rising trend which is interpreted as indicating a change in solubility of sphalerite in the medium with decreasing pH.

In Fig. 3-b are data showing the effect of pH on sedimentation rate of sphalerite in a 50-millimol per liter $ZnSO_4$ solution. Maximum dispersion is reached at a pH about 4, and there is a white precipitate of zinc hydroxide formed at pH about 6.3, which results in mass precipitation. The slight dispersion effect with decreasing pH corresponds to increased dispersion obtained with increasing molar concentration of zinc sulphate in the sedimentation curve, and is attributed to solubility change of the surface substance, and to such ions as ZnO^{--} or $ZnOH^-$. A critical ionization is reached at a pH about 4. Ionization decreases with increasing pH until precipitation of $Zn(OH)_2$ is reached at a pH between 6 and 7. Below pH of 4, ionization is so loosened that zinc cations are free swimming in the medium.

Copper Sulphate, $CuSO_4.5H_2O$.—This is an acid salt of an element more electropositive than zinc, and, therefore, one whose sulphide is less soluble than ZnS. The surface reaction is generally agreed to be $Cu^{++}+ZnS \rightarrow CuS+Zn^{++}$.

Copper atoms have replaced zinc atoms in the crystal lattice and there now exists in effect a covellite suspension in a zinc sulphate solution. The sedimentation curve reveals that copper sulphate is a precipitant of sphalerite, particularly in the very low molar concentrations. Since the reaction presented in the foregoing has taken place with expenditure of energy, there results a reduction in total energy of the system. Such a total free energy reduction manifests itself in a reduction of total surface (coagulation). It appears that every exchange (double decomposition) type of reaction must result in decreased dispersion. Silver ions and lead ions, whose sulphides also are less soluble than zinc sulphide, act similarly to copper anions.

Now we come to the consideration of several of the more important sodium salts. The salts in this group have two things in common: (1) the cation (sodium; in one case potassium) does not form insoluble precipitates with any of the anions under consideration, and hence does not have the "precipitating" or flocculating power often associated with heavy-metal cations, and (2) the anions are those which combine with hydrogen to form weak acids. The "associating power" or "affinity" of one group for another in an aqueous solution is measured by the degree of ionization of the salt of the two groups. When the ionization constant is very small, the associating power is great. Table III lists the ionization constants of the weak acids involved in our discussion. These are all very small, which means that all of the anions in this group have a strong affinity for hydrogen ions, and tend to remove them from the field of

action as ions and tie them up as neutral molecules of acid. The sphalerite lattice contains sulphur ions which tend to react with hydrogen ions to form the weak acid H_2S at the surface of the sphalerite particle. This acid ionizes slightly to give free-swimming H^+ ions and anchored S^{--} or HS^- ions, and it is the degree of ionization of this surface film which determines the stability (degree of dispersion) of the mineral suspension. The effect of salts of weak acids on the stability of sphalerite suspensions appears to be due to the ability of the weak acid anions to increase the ionization (weaken the "binding force" which holds the H^+ ions to the sulphur ions in the lattice) of the H_2S at the surface of the sphalerite particle. The explanations which follow are based on this premise.

In the previous paper, similar explanations were offered to account for the behavior of quartz suspensions on the assumption that the surface consisted of an ionized silicic acid with a silicate ion (*e.g.*, SiO_3^{--}) as the anchored ion. In the case of sphalerite, however, the picture is complicated by the fact that the surface contains not only sulphur ions, but also an equal number of zinc ions. Zinc forms insoluble salts with many of the anions used in these tests, and it is possible that in many cases the reaction of these ions with zinc and the resulting ionization of the zinc compound may have an effect on the stability of the suspension. This is kept in mind in the discussions which follow.

Ionization of these weak acids in aqueous medium is typified by the following example:

$$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$
$$\updownarrow$$
$$H^+ + CO_3^{--}$$

Hydroxyls drive the ionization to the right whereas hydrogens drive it to the left. For example, with carbonic acid in neutral solution, there is about 25 per cent H_2CO_3 and 75 per cent HCO_3^-. At a pH of 10, the material is 37 per cent CO_3^{--}, and 63 per cent HCO_3^-, with no H_2CO_3.

Sodium Carbonate—This reagent is widely used as a so-called conditioning agent in flotation of various ores. The nature of its effect on mineral suspensions is therefore of particular interest. Sodium carbonate, in low molar concentrations, about 2 to 3 millimols per liter, is a strong dispersant of sphalerite. Increasing concentrations reduce its potency. What is the mechanism of this dispersing power? It is thought to be represented by some such reaction as—

$$ZnS + H^+ + HCO_3^- \rightleftharpoons H_2CO_3 + (ZnS)S^-$$
Neutral $\updownarrow$ $\updownarrow$ anionic
HS^- $H^+ + CO_3^{--}$

The H^+ ion is the central figure and is being vied for by electrons of both S^{--} and HCO_3^- ions. Thus, S^{--} (or possibly HS^-) is the anchored ion, H^+ the free swimming, and HCO_3^- the restraining ion.

There is the probability too that the carbonate ion CO_3^{--} assists in tending to absorb the Zn valences or zinc covalences due to the insoluble nature of $ZnCO_3$ or the still less soluble basic zinc carbonate.

Thus, dispersion in this case is the result of two reactions: (1) one tending to produce an insoluble substance of which the cation (Zn^{++}) is a part, and (2) one in which the anion (S^{--}) takes part in a reversible type of reaction in which a weak acid (HS^- or H_2S) is involved.

Sodium Sulphide—This reagent has a well-known capacity to depress sphalerite when used in controlled critical amounts. The sedimentation curve shows that, in low concentrations (one or two millimols/liter), it is a potent dispersant of sphalerite. Increased concentration, as in the case of sodium carbonate, slowly destroys dispersion. Here it is believed, as a result of hydrolysis, the dispersion, as in the case of sodium carbonate, is the result of reactions suggested in the following:

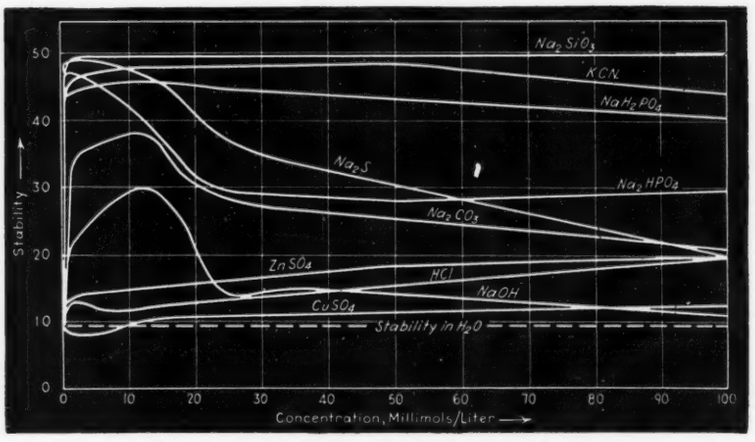


Fig. 3 . . . SEDIMENTATION CURVES for certain weak acid sodium salts among others, the group being chosen principally because of its usefulness in flotation

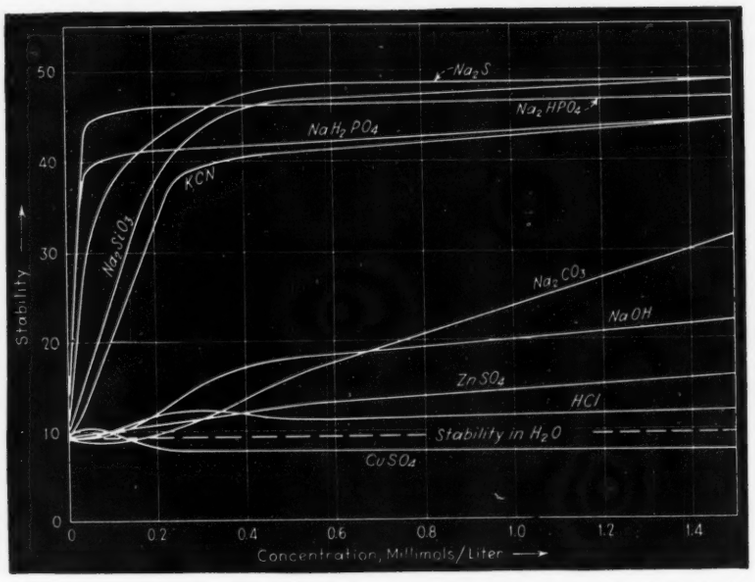


Fig. 3a . . . SETTLING CURVES are shown for the same reagents as those dealt with in Fig. 3. The increment of solute concentration variation is much smaller than in the former case

$$ZnS + H^+ + HS^- \rightleftharpoons H_2S + (ZnS)S^{--}$$
$$\text{and } (ZnS)Zn^{++} + OH^- \rightleftharpoons Zn(OH)_2$$
$$HZnO^- + H^+ \rightleftharpoons Zn(OH)_2$$
$$\rightleftharpoons Zn^{++} + 2OH^-$$

Falling off of the sedimentation curve with increasing solute concentrations presumably is due primarily to increasing concentration of hydroxyl ion and its enhancing effect upon the ionization of HS^- and/or H_2S, and to increasing solubility of the amphoteric $Zn(OH)_2$ to give the zincate ion $HZnO^-$ or ZnO_2^{--}.

Potassium Cyanide—Cyanide is the universal sphalerite flotation depressant and is the most potent of any so far discovered. It is a strong dispersant of sphalerite, reaching its highest potency at a solute concentration of one or two millimols per liter. The sedimentation curve, unlike that of soda ash and sodium sulphide, is depressed much more slowly with increasing molar concentration after a maximum has been reached.

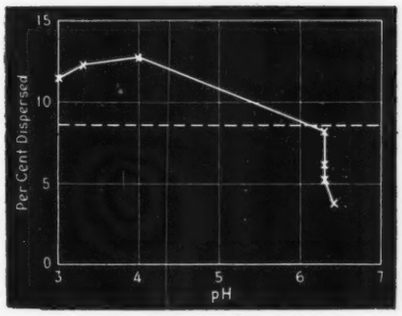


Fig. 3b . . . EFFECT OF pH on the sedimentation rate of sphalerite in a 50-millimol-per-liter $ZnSC_4$ solution. The pH is varied by means of HCl and NaOH

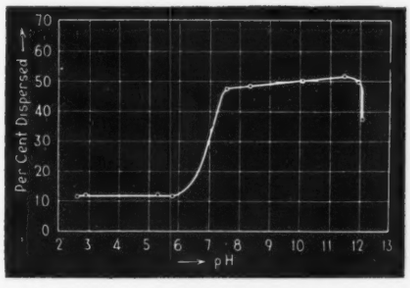


Fig. 3c . . . DISPERSION here is plotted against a variable pH. The concentration is constant at 1 millimol KCN per liter in all tests

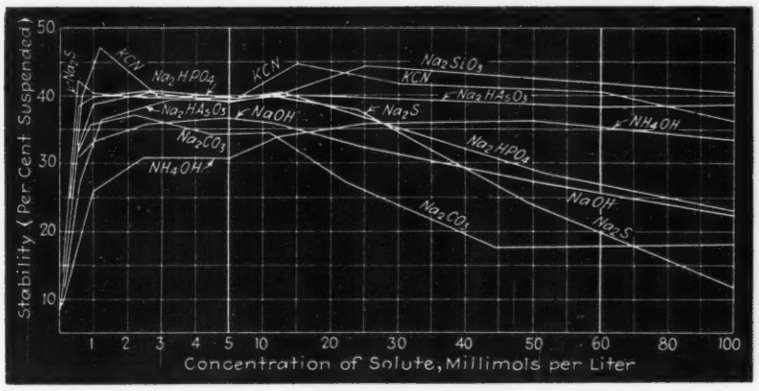


Fig. 4a . . . SEDIMENTATION CURVES for a group of salts with concentrations of the solutes ranging up to 100 millimols per liter. The curve for NH_4OH shows that its dispersion of sphalerite is strong over the greater part of this concentration range

Dispersion in this case is attributed to hydrogen ion, assisted by insoluble properties of zinc cyanide. The reactions possibly are as follows:

$$ZnS + H^+ + CN^- \rightleftharpoons HCN + (ZnS)S^-$$

Neutral — Anionic (1)

$$(ZnS)Zn^{++} + 2CN^- \longrightarrow Zn(CN)_2 \quad (2)$$

$$Zn(CN)_2 + 2CN^- \rightleftharpoons Zn(CN)_4^{--} \quad (3)$$

All three reactions take place simultaneously. The zinc atoms in the lattice made momentarily cationic through the tendency for the sulphur valences to hook up with H^+ are immediately consumed by reaction with CN^- forming insoluble $Zn(CN)_2$. Falling off of the sedimentation curve with increase in solute concentration, which is much slower than for Na_2S or Na_2CO_3, is due to a loosening (increasing) ionization of HCN with increasing OH^- concentrations and to increasing solubility of $Zn(CN)_2$ in increasing CN^- ion concentration, in accordance with the third equation in the foregoing group.

In Fig. 3-c for a constant (1 millimol/liter) CN^- concentration, dispersion is plotted against variable OH^- concentration (pH). Hydroxyls, as well as hydrogens, are seen to have a precipitating (de-stabilizing) effect on cyanide dispersed sphalerite. The trend of the sedimentation curve undoubtedly is related to the effect of pH on (1) the ionization constants of H_2S and HS^-—*i.e.*, loosening of the bonding force between S^{--} and H^+, and of H^+ and CN^-, and on (2) the solubility of $Zn(CN)_2$.

In the case of the carbonate and the sulphide of sodium, the hydrate of zinc, which presumably is formed, is decreasingly soluble with increasing hydroxyl concentration.

Sodium Acid Phosphate—The sedimentation curve of this reagent closely resembles that of cyanide. All the remarks offered for cyanide hold in this case. The reactions thought to be involved are as follows:

$$HPO_4^{--} + H^+$$
$$\uparrow\downarrow$$
$$(Zn) + H^+ + H_2PO_4^- \rightleftharpoons H_3PO_4 + (ZnS)S^{--}$$
$$(ZnS)\ Zn^{++} + PO_4 \longrightarrow \text{zinc phosphate}$$

Ionization is not much loosened with increasing solute concentration due to the acidic character of this salt and to little change in solubility of the zinc phosphate. Strong dispersion obtains over a considerable concentration range.

Sodium Dibasic Phosphate — This salt gives a modestly strong basic reaction, due (1) to its two sodium atoms, and (2) to the extreme low ionization constant (K_2, $2x10^{-7}$) of the acid HPO_4^{--}.

Like the acid phosphate, dibasic phosphate, in minute molar concentration, is a strong dispersant of sphalerite. Its sedimentation curve, however, falls off more rapidly than the acid phosphate. The explanation clearly is to be found in the more rapidly increasing pH. The increasing hydroxyl concentration in the case of the more basic phosphate enhances ionization of the weak acids involved, thus loosening the bonds between the negative ionic field of the sulphur atoms in the sphalerite lattice and hydrogen ions. Also, as the system becomes more distinctly alkaline there would be a tendency to form one of the insoluble zinc orthophosphates, $Zn_3(PO_4)_2.xH_2O$.

The sedimentation curves of these two sodium phosphates display clearly the influence of pH on dispersion, and the data here obtained bring out the factors causing dispersion perhaps better than any other available.

Sodium Silicate—Sodium silicate is a strong dispersant of sphalerite. Its sedimentation curve slightly tops all others and there is no depression of the curve in the higher solute concentrations employed.

The hydrolytic products of this salt are the weak acid H_2SiO_3 and OH^-. In accordance with the ionic process herein employed to account for dispersion, the reactions involved are the following:

$$(ZnS) + H^+ + HSiO_3^- \text{ (or } SiO_3^{--}) \rightleftharpoons H_2SiO_3 + (ZnS)S^{--}$$

$$(ZnS)\ Zn^{++} + SiO_3^{--} = ZnSiO_3$$

The anchored ion here, as in similar cases considered in the foregoing, may be HS^- in lieu of S^{--} and the insoluble surface may be some other zinc silicate than that indicated. The theory, however, remains the same.

Another dispersant of this type is sodium arsenite, Na_2HAsO_3. The sedimentation curve will be shown later when it is employed in relation to flotation data.

Sodium Hydroxide — Initial small additions of this strong base have a modest dispersion effect on sphalerite. Continued additions of the solute, however, repress dispersion to a degree approaching that of sphalerite in water. Here it is not clear whether ionization of sphalerite is due to S^{--} or to a complex of the zinc atom. In the presence of such a strongly basic medium, H_2S or HS^- could not exist over a wide solute concentration range, and it would seem that any tendency toward dispersion in the initial small solute concentration would be quickly

Table I—Sphalerite Settling Data

Charge, 2 gm.; Temperature, 25°C; Solute, Sodium Silicate

Test No.	Solute Mm./L	pH of Solution Before	After	Stability (a)
1	0.0	6.6	6.8	(b) 9.3
2	0.05	7.0	6.9	18.3
3	0.25	9.0	7.3	41.5
4	0.50	9.5	8.7	46.9
5	1.50	10.6	9.1	49.2
6	2.50	10.8	9.4	48.7
7	5.00	10.5	9.6	48.8
8	7.50	10.5	9.6	49.2
9	12.50	10.5	9.6	49.3
10	25.00	10.4	10.1	49.2
11	50.00	10.7	10.6	50.0
12	100.00	10.8	10.8	49.9

(a) Per cent remaining in suspension after 3 minutes.
(b) Settling rate in distilled water.

Solute $ZnSO_4$

1	0.0	..	..	9.3
2	0.5	..	..	12.9
3	5.0	..	..	14.3
4	25.0	..	..	16.2
5	50.0	..	..	18.4
6	100.0	..	..	19.9

Solute NaOH

1	0.00	6.6	6.8	9.3
2	0.05	7.4	7.0	9.0
3	0.25	10.4	7.2	13.4
4	0.50	10.6	9.2	18.1
5	1.50	10.8	10.6	22.3
6	2.50	11.6	10.7	26.1
7	5.00	11.8	11.0	24.4
8	7.50	11.9	11.8	26.1
9	12.50	12.0	11.9	30.3
10	25.00	12.1	12.1	13.9
11	50.00	12.6	12.6	14.5
12	100.00	12.6	12.6	11.0

Solute KCN

1	0.00	6.6	7.0	9.3
2	0.05	7.2	7.1	13.9
3	0.25	9.1	8.4	38.3
4	0.50	9.4	8.6	41.1
5	1.50	9.6	9.4	44.5
6	2.50	9.6	9.6	45.9
7	5.00	9.8	9.6	47.3
8	7.50	10.2	9.6	47.2
9	12.50	10.4	10.4	48.1
10	25.00	10.6	10.5	48.2
11	50.00	11.0	10.7	48.6
12	100.00	11.5	11.4	44.2

Solute Na_2CO_3

1	0.00	6.6	6.8	9.3
2	0.05	7.0	6.9	8.9
3	0.25	10.8	7.3	10.3
4	0.50	10.8	7.4	16.1
5	1.50	10.8	9.6	31.5
6	2.50	10.8	9.6	31.4
7	5.00	10.8	10.2	36.2
8	7.50	10.8	10.5	37.2
9	12.50	10.9	10.7	38.3
10	25.00	11.0	10.8	28.5
11	50.00	11.6	10.8	25.5
12	100.00	11.6	11.0	22.0

Solute HCl

1	0.00	6.6	7.3	9.3
2	0.05	4.8	6.8	9.5
3	0.25	3.6	6.6	12.4
4	0.50	3.3	6.3	11.4
5	1.50	2.8	6.0	12.3
6	2.50	2.6	5.5	12.9
7	5.00	2.6	3.1	11.5
8	7.50	2.6	2.6	12.4
9	12.50	2.6	2.6	13.2
10	25.00	2.6	2.6	15.7
11	50.00	2.6	2.6	15.6
12	100.00	2.6	2.6	19.7

Solute, Sodium Sulphide

1	0.00	6.6	6.9	9.3
2	0.05	7.2	7.1	30.6
3	0.25	9.6	7.2	43.5
4	0.50	10.4	8.5	48.5
5	1.50	10.8	10.5	49.3
6	2.50	11.6	10.8	48.6
7	5.00	11.8	11.6	48.1
8	7.50	11.9	11.7	47.7
9	12.50	12.0	12.0	46.0
10	25.00	12.3	12.1	37.1
11	50.00	12.6	12.6	30.5
12	100.00	12.6	12.6	19.8

suppressed. The alternative to which dispersion may be attributed is the zincate ion ZnO_2^{--}. It is, however, said that $Zn(OH)_2$ does not dissolve in alkali solutions as dilute as 0.1 N. This fact throws us back to the HS^- anion, which is the weakest of all acids, as the factor most probably responsible for ionization of sphalerite in weak NaOH solutions.

Ammonium Hydroxide. (Fig. 4-a)—Although a strong base, this reagent is a quite potent dispersant of sphalerite. Cataphoretic tests show that the suspension is negative, which fact eliminates the stable complex $Zn(NH)_4^{++}$ as a factor. The explanation for sodium hydroxide, right or wrong, applies for this solute. Note that the sedimentation curve shows that dispersion holds up strong over a long range of concentration.

Salts, such as NaCl and Na_2SO_4, have little or no effect on sphalerite. They are not expected to, since sodium salts are highly soluble and hydrolysis does not give a weak acid. The strong acids also do not qualify as dispersants.

(To be continued)

Solute, Na_2HPO_4

1	0.00	6.6	6.9	9.3
2	0.05	7.3	6.9	44.5
3	0.25	7.6	7.3	46.1
4	0.50	8.0	7.4	46.6
5	1.50	8.5	7.9	47.2
6	2.50	8.6	8.0	47.1
7	5.00	8.8	8.3	44.6
8	7.50	8.9	8.5	43.2
9	12.50	9.0	8.7	38.8
10	25.00	9.0	8.7	28.4
11	50.00	9.1	8.9	27.1
12	100.00	9.1	9.0	29.7

Solute NaH_2PO_4

1	0.0	6.6	6.8	9.3
2	0.05	6.4	6.7	38.2
3	0.25	5.8	6.1	41.5
4	0.50	5.6	6.1	42.1
5	1.50	5.3	5.8	44.2
6	2.50	5.2	5.6	44.8
7	5.00	4.9	5.6	45.0
8	7.50	4.8	5.5	45.5
9	12.50	4.6	5.5	45.7
10	25.00	4.5	5.3	44.8
11	50.00	4.4	5.1	43.2
12	100.00	4.5	4.9	40.0

Solute $CuSO_4$

1	0.0	6.6	6.7	9.3
2	0.05	6.3	6.4	10.5
3	0.25	5.9	5.5	7.9
4	0.50	5.8	5.1	7.9
5	1.50	5.4	4.8	7.8
6	2.50	5.2	4.5	8.3
7	5.00	5.1	4.9	8.9
8	7.50	5.0	4.7	8.6
9	12.50	5.0	5.4	10.0
10	25.00	4.9	5.1	11.0
11	50.00	4.6	4.8	11.0
12	100.00	4.5	4.7	12.8

Table III—Ionization Constants of Some Weak Acids

Acid	First H	Second H	Third H
H_2CO_3	$3x10^{-7}$/18°	$6x10^{-11}$/25°	
H_2S	$9.1x10^{-8}$/18°	$1.2x10^{-15}$/25°	
HCN	$7.2x10^{-10}$/25°		
H_3PO_4	$1.1x10^{-2}$/18°	$2x10^{-7}$/18°	$3.6x10^{-13}$/18°
H_3AsO_3	$6x10^{-10}$/25°		
H_3AsO_4	$5x10^{-3}$/25°	$4x10^{-8}$/25°	$6x10^{-10}$/25°
HOH	10^{-14}		

Table II—Solubilities of Some Slightly Soluble Zinc Compounds

Substance	Solubility Gm. in 100 c.c. water	Solvents
ZnS	$0.000065^{18°}$	Acids
ZnO	$0.00016^{29°}$	Acids, alkalies, NH_4Cl
$Zn(OH)_2$	$0.00042^{18°}$	Acids, alkalies
$2ZnCO_3.3Zn(OH)_2$	Insol.	Dilute acids, NH_4OH, $NH_4(CO_3)$
$Zn(CN)_2$	Insol.	Alkalies, KCN, NH_3
$ZnCO_3$	$0.001^{18°}$	Acids, alkalies, NH_3
$ZnSiO_3$	Insol.	
$Zn(AsO_4)_2.8H_2O$	Insol.	HNO_3, H_3AsO_4, alkalies
$Zn_3(PO_4)_2$	Insol.	Acids, NH_4OH, NH_4 salts
$Zn_3(PO_4)_2.4H_2O$	Insol.	Acids, NH_4OH, NH_4 salts
$Zn_3(PO_4)_2.8H_2O$	Insol.	Alkalies

Tape Breaks In Unusual Way

BREAKAGE of a 100-ft. steel tape in a most unusual way is illustrated in the accompanying cut. The tape was used by a four-man party in a student survey of the underground workings of an iron mine, according to F. M. Lambert, professor of mining engineering, Minnesota School of Mines, Minneapolis, Minn. At the conclusion of the work, in June, 1937, the boys asked permission to take the tape to their rooms and clean it before inspection. When presented, it was in the condition shown.

There are 145 separate, distinct, and complete breaks, 88 on the left-hand side, from the core outward, and 57 on the right-hand side, from the fore outward. In addition to these complete breaks there were many small wedge-shaped pieces of the tape about 0.005 ft. wide at the base, tapering to a point, and about three-quarters the width of the tape in length, which were broken off, adjacent to the fracture zone. The reel was not injured in any way. It is evident that the tape broke after it had been reeled up.

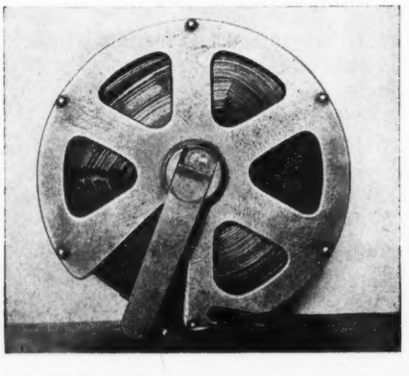
The students were unable to give any explanation of the phenomenon other than that the tape was found broken, as shown, the morning after being cleaned and reeled up. No one of the many engineers to whom the tape had been shown has ever seen anything like it, nor could they offer any feasible explanation.

On the return of the students in the fall, the boys were questioned, and it developed that the tape had been soaked in white-wine vinegar for a few hours to aid in removing the iron ore stains. This was the key to the mystery. The metallographic department now diagnosed the disease as "hydrogen embrittlement."

An attempt was made to reproduce the phenomenon by subjecting a discarded tape to the same treatment, but without success.

The brittleness of an untreated tape

THE BREAKS that were found in the tape after soaking in white-wine vinegar can be seen here



Sodium Sulphate

From the Shore Of Great Salt Lake

Utah company recovering pure product from glauber shales beneath Saltair Beach

Gail Martin
Salt Lake City, Utah

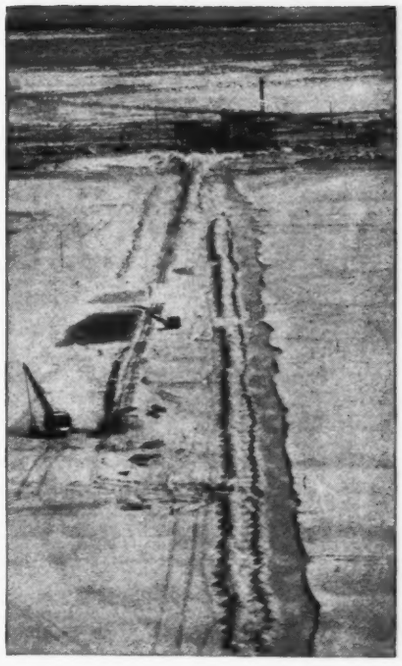
STEADY PRODUCTION of sodium sulphate by the Salt Lake Sodium Products Company on the southeast shore of Great Salt Lake near Salt Lake City marks the end of a long period of experimentation, during which several attempts have been made to produce a chemically pure sodium sulphate out of a bed of glauber shales underlying the Saltair Beach about 2 ft. below the sand.

Refining of glauber salts involves no chemical problem. The process is chiefly mechanical. After testing various kinds of equipment and treatment, the company has succeeded in working out what it believes to be an economical and efficient process.

The bed containing the glauber salt consists mainly of sodium sulphate, water of crystallization, and sand. In 5 tons of ore, there are 1 ton of sodium sulphate, 1 ton of water, and 3 tons of sand. The ore is scooped up by a gasoline-driven dragline and hauled in cars propelled by a gasoline engine to the plant a quarter of a mile away. Refining consists of crushing, dissolving the salt, eliminating the sand by classifiers, settling the solution, and evaporating and converting it into crystals.

Thickness of the ore bed ranges from 2 to 10 ft. Holes 1½ in. by 2 ft. deep are drilled with augers. Blasting is done with a No. 30 gelatine powder. The salt formation is so hard that it defies all efforts to drive holes in it with steel piles. To drive the piles for the near-by Saltair Pavilion years ago, steam had to be piped to the bed, this dissolving the salt readily. Twenty-four hours after being set in place, the piles were immovable. This quick-setting characteristic makes it impractical to store the ore in bins for any long period.

The dull gray ore is put through roll crushers, delivered by conveyor to a melter tank, and mixed by propeller agitators with water heated to 150 deg. F. by a four-pass heater using exhaust steam. It remains in the melter tank for 15 minutes, then overflowing into a 5x16-ft. Dorr classifier, where the sand is removed.



PLANT of Salt Lake Sodium Products Company on shore of Great Salt Lake. The workings and the excavators are seen in the foreground

The classifier overflow passes to three 16x18-ft. settling tanks, where it stays 24 hours. Centrifugal pumps then force it through a four-pass heater, where it is again heated to 150 deg. F. The brine is then passed through three vertical evaporators, heated by exhaust steam.

A 30 in. by 16-ft. Dorr classifier receives the salt as it comes from the evaporators in crystalline form. The rake product is delivered to a centrifugal, where the sodium sulphate is separated from the brine. This with the overflow from the classifier circulates back to the evaporators and the salt cake passes to a 4x18-ft. horizontal kiln dryer. Elevators raise the dry sodium sulphate to a 30-mesh screen. After being screened, it is stored for shipment either in bulk or sacks. A 250-hp. Sterling boiler supplies steam for heating and power. Slack coal is used for fuel.

The finished product is pure white, fine, crystalline, with no foreign matter visible and almost completely soluble in water. The analysis made by the Utah State Chemist shows: Moisture, 0.02 per cent; water-insoluble, silica, 0.04; calcium sulphate, 0.35; iron, none; magnesium sulphate, 0.15; potassium sulphate, 0.78; sodium chloride, 0.57; phosphates, carbonates, nitrates, none; sodium sulphate, 97.94 per cent.

Because of its excellent quality, the product is finding a ready market with jobbers, who supply it to the kraft paper and fiber industry, and the rayon, plate glass, soap, textile, ink and dye manufacturers.

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was then determined by subjecting it to a bending test. The tape was placed between two steel jaws, the corners of which had been rounded off to a ¼-in. radius, and bent alternately over each of those round jaws. The bending was done at timed intervals and each time the tape was pressed firmly into contact with the corner and top of the jaw. The average number of turns required to break the tape was 3¾.

In the next test a piece of the same tape was pickled in vinegar for sixteen hours and then subjected to the same test. The average number of turns to break the tape had been reduced to 2¼. This proved conclusively that the breaks were caused by the vinegar bath.

The tape is graduated to hundredths of a foot throughout its length by an etching process, the graduation marks being raised. The tenth-of-a-foot graduations extend across the full width of the tape, but the hundredth marks extend only halfway across. The tape would invariably break with a smaller number of turns at a tenth mark than at a hundredth. This raised the question as to the immediate cause of the breaks. Whether they were directly due to hydrogen embrittlement or increased depth of etching along the already weakened etched lines will have to be determined by further research. In either case the weakened tape was tightly reeled up, the coils were slightly bent out of a true spiral by a rivet used to attach the ribbon to the core. It was at this place that the breaks occurred.

Summary of the

MARKETS

THE month of May witnessed little if any improvement in the demand for non-ferrous metals, and, with production in excess of requirements, prices weakened. Lower quotations were established for copper, lead, zinc, tin, and antimony. The *E.&M.J.* index of metal prices dropped from 71.19 in April to 69.15 in May. A year ago the index stood at 93.25.

The low rate of activity at fabricating plants and the steady accumulation of supplies in the hands of producers are finally forcing output down to the point where it is hoped that stocks will no longer increase. In copper, the curtailment promises to be of such magnitude that the industry looks for more than a balanced condition between production and consumption by early summer.

Domestic copper broke to 9c., Valley, on May 19. This is the lowest price named since Oct. 7, 1935. The decline did not bring in any new business, as London quotations fell considerably below the domestic level, and talk of a further reduction was widespread. Disappointing April statistics for the domestic industry and the decline abroad caused the break in the market. There was some delay in issuing the foreign data, but when this information was released and found to be favorable the extreme bearishness diminished, particularly in London. The sharp curtailment in production announced by the domestic producers served to steady the 9c. domestic quotation.

There were two 25-point reductions in lead as demand failed to pick up and stocks of refined metal increased 13,204 tons during April. Another increase is expected for May.

Prime Western zinc was reduced to 4c., St. Louis. There was some inquiry for third-quarter zinc at this level, but producers confined their selling to the near-by positions.

Malaya voted to come into the Buffer Pool, which was followed by firmer prices for tin. Surplus supplies of quicksilver moved into firm hands and the price was advanced sharply.

UNITED STATES MARKET

1938	Electrolytic Copper Domestic (a)	Electrolytic Copper Export (b)	Straits Tin New York	Lead New York	Lead St Louis	Zinc St. Louis
May						
2	9.775	9.300	35.125	4.50	4.35	4.15
3	9.775	9.275	35.125	4.50	4.35	4.15
4	9.775	9.300	36.875	4.50	4.35	4.15
5	9.775	9.325	37.625	4.50	4.35	4.15
6	9.775	9.300	37.625	4.50	4.35	4.15
7	9.775	9.325	38.000	4.50	4.35	4.15
9	9.775	9.275	37.850	4.50	4.35	4.15
10	9.775	9.325	38.000	4.50	4.35	4.00
11	9.775	9.300	37.800	4.50	4.35	4.00
12	9.775	9.275	38.250	4.50	4.35	4.00
13	9.775	9.275	38.100	4.50	4.35	4.00
14	9.775	9.250	38.000	4.50	4.35	4.00
16	9.775	9.125	37.125	4.50	4.35	4.00
17	9.775	9.075	36.350	4.50	4.35	4.00
18	9.775	9.050	36.625	4.50	4.35	4.00
19	8.775	8.950	36.600	4.50	4.35	4.00
20	8.775	8.450	35.850	4.50	4.35	4.00
21	8.775	8.450	35.850	4.50	4.35	4.00
23	8.775	8.250	36.500	4.25	4.10	4.00
24	8.775	8.200	37.200	4.25	4.10	4.00
25	8.775	8.025	36.750	4.25	4.10	4.00
26	8.775	7.850	36.150	4.25	4.10	4.00
27	8.775	7.850	35.800	4.00	3.85	4.00
28	8.775	7.925	36.200	4.00	3.85	4.00
30	Holiday	8.000	Holiday	Holiday	Holiday	Holiday
31	8.775	8.100	36.750	4.00	3.85	4.00
For Month Average	9.375	8.801	36.885	4.400	4.250	4.042
May	AVERAGES FOR WEEK					
4	9.775	9.383	36.217	4.500	4.350	4.150
11	9.775	9.308	37.817	4.500	4.350	4.100
18	9.775	9.175	37.408	4.500	4.350	4.000
25	8.775	8.388	36.458	4.375	4.225	4.000
May	CALENDAR WEEK AVERAGES					
7	9.775	9.304	36.729	4.500	4.350	4.150
14	9.775	9.283	38.000	4.500	4.350	4.025
21	9.275	8.850	36.400	4.500	4.350	4.000
28	8.775	8.017	36.433	4.167	4.017	4.000

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

1938	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
May						
2	4.985000	4.978750	42.750	18.6875	139s 6½d	$35.00
3	4.986250	4.979375	42.750	18.6250	139s 6d	35.00
4	4.987500	4.980625	42.750	18.6250	139s 6d	35.00
5	4.990000	4.983125	42.750	18.6250	139s 7d	35.00
6	4.988750	4.981250	42.750	18.6250	139s 8d	35.00
7	4.980000	4.972500	(e)	18.6875	139s 8½d	35.00
9	4.976875	4.970000	42.750	18.6875	139s 10d	35.00
10	4.976875	4.970000	42.750	18.6875	139s 9½d	35.00
11	4.971875	4.965000	42.750	18.6875	139s 11d	35.00
12	4.973750	4.966875	42.750	18.6875	139s 10½d	35.00
13	4.973750	4.966250	42.750	18.6875	139s 11d	35.00
14	4.968125	4.961250	(e)	18.7500	139s 11d	35.00
16	4.965000	4.958125	42.750	18.7500	140s 1d	35.00
17	4.966875	4.960000	42.750	18.7500	140s 1½d	35.00
18	4.970000	4.963125	42.750	18.6875	140s	35.00
19	4.964375	4.957500	42.750	18.6875	140s 1½d	35.00
20	4.968125	4.961875	42.750	18.7500	140s 1½d	35.00
21	4.956250	4.949375	(e)	18.7500	140s 1½d	35.00
23	4.951250	4.944375	42.750	18.7500	140s 4½d	35.00
24	4.951875	4.945625	42.750	18.6875	140s 4½d	35.00
25	4.941250	4.935000	42.750	18.8125	140s 7½d	35.00
26	4.939375	4.933125	42.750	18.8125	140s 9d	35.00
27	4.940000	4.933750	42.750	18.8125	140s 9d	35.00
28	4.945000	4.938750	(e)	18.8750	140s 9d	35.00
30	Holiday	Holiday	Holiday	18.8750	140s 5½d	Holiday
31	4.950000	4.943750	42.750	18.9375	140s 5½d	35.00
Average for Mo.	4.96673	.....	42.750	18.731	.....	35.00
May	AVERAGES FOR WEEK					
4	4.98635	.....	42.750	.....	.....	.....
11	4.98073	.....	42.750	.....	.....	.....
18	4.96958	.....	42.750	.....	.....	.....
25	4.95552	.....	42.750	.....	.....	.....

Calendar week averages: New York Silver May 7th, 42.750; 14th, 42.750; 21st, 42.750; 28th, 42.750.

(e) Not quoted; Saturday.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.350c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order effective Jan. 1, 1938, the U. S. Government's price on newly mined domestic silver was established at 64.64c. Handy & Harman's quotation for domestic silver, 999 fine, was 64⅛c. per ounce throughout May.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quotated by the Treasury, which at present is equal to $34.9125 per ounce.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1938	COPPER			TIN		LEAD				ZINC			
	Standard		Electro	Standard		Spot		3 months		Spot		3 months	
May	Spot	3 months	Bid	Spot	3 months	Buyers	Sellers	Buyers	Sellers	Buyers	Sellers	Buyers	Sellers
2	38.5625	38.8125	42.5000	155.0000	156.0000	14.6875	14.7500	14.8125	14.8750	12.3750	12.4375	12.5625	12.6250
3	38.1875	38.4375	42.2500	153.2500	153.8750	14.4375	14.5000	14.6250	14.6875	12.6250	12.6875	12.9375	13.0000
4	38.6250	38.9375	43.0000	160.0000	160.7500	14.8750	14.9375	15.0625	15.1250	12.8750	12.9375	13.1250	13.1875
5	38.9375	39.1875	43.0000	169.1250	169.5000	15.0000	15.0625	15.1250	15.1875	13.1250	13.2500	13.3750	13.4375
6	38.5000	38.7500	43.0000	165.7500	166.2500	14.7500	14.8125	14.8750	14.9375	13.0625	13.1250	13.3125	13.3750
9	38.5625	38.7500	43.0000	167.7500	168.2500	14.5625	14.6250	14.7500	14.8125	12.8750	12.9375	13.0625	13.1250
10	39.1875	39.3750	43.0000	167.7500	168.5000	14.6875	14.8125	14.8750	14.9375	13.0000	13.1250	13.2500	13.3125
11	38.8750	39.0625	42.7500	167.5000	168.0000	14.6250	14.6875	14.7500	14.8125	13.0000	13.0625	13.1875	13.2500
12	38.6875	38.9375	42.7500	169.0000	169.5000	14.5000	14.5625	14.6875	14.7500	12.9375	13.0000	13.1250	13.1875
13	38.5625	38.7500	42.5000	168.2500	169.0000	14.3125	14.3750	14.5625	14.6250	12.8750	12.9375	13.0625	13.1250
16	38.2500	38.5000	42.2500	165.6250	166.0000	14.3125	14.4375	14.5000	14.5625	12.8125	12.8750	13.0000	13.0625
17	37.9375	38.2500	41.7500	162.2500	162.7500	14.1250	14.2500	14.3125	14.3750	12.6875	12.8125	12.9375	13.0000
18	37.5625	37.8125	42.0000	161.7500	162.2500	14.1250	14.1875	14.2500	14.3125	12.6250	12.7500	12.8125	12.9375
19	37.1250	37.3750	41.0000	162.2500	162.7500	13.8125	13.8750	14.0000	14.0625	12.5625	12.6250	12.7500	12.8125
20	35.0625	35.3125	39.5000	158.2500	158.7500	13.4375	13.5625	13.6250	13.7500	12.3125	12.3750	12.5625	12.6250
23	34.1250	34.3750	38.5000	159.5000	160.2500	13.5625	13.6250	13.7500	13.8125	12.3750	12.4375	12.5625	12.6250
24	34.0000	34.2500	38.2500	161.0000	161.7500	13.8750	13.9375	14.1250	14.1875	12.5625	12.6875	12.6875	12.7500
25	33.2500	33.5000	38.0000	162.7500	163.5000	13.7500	13.8750	14.0000	14.0625	12.5000	12.6250	12.6250	12.6875
26	32.7500	33.0000	37.0000	159.5000	160.2500	13.5625	13.6875	13.7500	13.8125	12.1875	12.2500	12.3750	12.5000
27	32.5000	32.8125	37.0000	157.5000	158.3750	13.3125	13.4375	13.5000	13.5625	12.0000	12.0625	12.2500	12.3125
30	33.6875	33.9375	37.7500	161.2500	162.0000	13.6875	13.8125	13.8125	13.8750	12.3750	12.5000	12.4375	12.5000
31	33.7500	34.0000	38.0000	164.2500	164.7500	13.6875	13.7500	13.8125	13.8750	12.3125	12.4375	12.3750	12.4375
Average for Month	36.668	.....	40.852	.....	.....	14.210		14.376		12.682		12.869	

Prices for lead and zinc are the official prices for the first session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton of 2,240 lb.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(June 1, 1938)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb ..... 20c.
Antimony, domestic, spot, lb ..... 11.75c.
Bismuth, ton lots, lb $1.05
Cadmium, lb ..... 85c. @$1.20
Calcium, lb., ton lots 98 @ 99 per cent ..... 75c.
Chromium, 97 per cent grade, lb ..... 85c.
Nickel, electrolytic cathodes, lb ..... 35c.
Magnesium, 99.8 per cent, carloads, lb ..... 30c.
Palladium, troy oz $24.00
Platinum, (Official quotation) troy oz $33.00
Quicksilver, flask of 76 lb., 100 flasks or more ..... $82.00@$84.00
Radium, mg. radium content $40.00
Selenium, 99.5 per cent, lb $2.00
Silicon, minimum 97 per cent, spot, lb ..... 16.50c.
Tellurium, lb ..... $1.75@$2.00
Thallium, 100 lb. or more, lb $6.50
Titanium, 96 to 98 per cent, lb $6.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton ..... $30.00@$35.00
Chrome Ore, 48 @ 50 per cent, c.i.f. Atl. ports, long ton ..... $24.00@$26.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:
- Old Range bessemer $5.25
- Mesabi bessemer $5.10
- Old Range non-bessemer $5.10
- Mesabi, non-bessemer $4.95

Lead (Galena) 80 per cent, Joplin, Mo., ton $42.14
Manganese Ore, c.i.f. Atlantic ports, long ton unit:
- 52 @ 55 per cent ..... 40c.
- 50 @ 52 per cent ..... 40c.
- 44 @ 48 per cent ..... 36c.

Molybdenum Ore, 90 per cent, per lb. of contained MoS_2 ..... 45c.
Tungsten Ore, per unit of WO_3:
- Chinese, 65 per cent, duty paid $17.00
- Domestic, 70 per cent and upward ..... (a)$18.00@$20.00

Vanadium Ore, per lb. of contained V_2O_5 ..... 27½c.
Zinc, Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton $27.00
(a) Prices at mines, small lots, usually several dollars less.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb 3c
Cobalt Oxide, 70 @ 71 per cent, lb ..... $1.67@$1.77
Copper Sulphate, 100 lb $4.00
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb $1.42
Sodium Sulphate, bulk, ton ..... $13.00@$15.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be $23.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb ..... 10½c.
Ferromanganese, 78 @ 82 per cent, gross ton $102.50
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo contained. 95c
Ferrosilicon, 50 per cent, gross ton $69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained ..... $1.80@$1.85

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:
- Canadian (Quebec)
  - Crude No. 1 ..... $700@$750
  - Crude No. 2 ..... $150@$350
  - Spinning fibers ..... $110@$200
  - Paper stock ..... $40@$45
  - Shorts ..... $12@$16.50
- Vermont
  - Shingle stock $57
  - Paper stock $40
  - Cement stock $25

Barytes, long ton:
- Georgia, crude $7.00
- Missouri, 90 per cent $BaSO_4$, less than 1 per cent iron ..... $6.00@$7.00

Bauxite, long ton:
- Domestic, chemical, 55 @ 58 per cent ..... $6.50@$7.50
- Domestic, abrasive, 70 @ 84 per cent ..... $12.50@$15.00
- Dalmatian, 50 @ 55 per cent ..... (a)$6.50@$7.50
- French, 56 @ 59 per cent ..... (a)$8.00@$9.00

China Clay, f.o.b. mines, ton:
- South Carolina and Georgia, No. 1, bulk ..... $6.75@$8.00
- Delaware, No. 1 ..... $14.50

Feldspar, bulk, ton:
- Potash feldspar, 200 mesh $17.00
- Glass-spar, white, 20 mesh $11.75

Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton ..... $18@$19
Fuller's earth, f.o.b. Georgia or Florida, ton ..... $7.00@$14.00
Magnesite, per ton:
- Dead-burned, f.o.b. California $22.00
- Dead-burned, f.o.b. Washington $22.00

Mica, per lb., North Carolina, No. 1 and 2 quality:
- 1½ x 2 in ..... 15@40c.
- 2 x 2 in ..... 30@60c.
- 3 x 3 in ..... 75@$1.20
- 3 x 4 in ..... $1.00@$1.40
- 4 x 6 in ..... $2.00@$2.50
- White, ground, 70 mesh, ton ..... $60.00@$80.00

Ocher, Georgia, ton ..... $19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports ..... (a) 12@12½c.
Silica, in bags, 325 mesh, ton ..... $18.00@$40.00
Sulphur, Texas mines, long ton $18.00
Talc, f.o.b. works, ton:
- New York, double air-floated, 325 mesh ..... $12.00@$15.00
- New Jersey, mineral pulp ..... $8.00@$10.00
- Vermont, extra white, 200 mesh ..... $9.00@ $9.50

Tripoli, Missouri, ton:
- 40 mesh, cream colored $14.50
- 200 mesh, cream colored $26.00

(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:
- Bessemer $24.50
- Basic $23.50
- No. 2 Foundry $24.00

Steel, base prices, Pittsburgh:
- Billets, gross ton $37.00
- Structural shapes, 100 lb $2.25
- Bars, 100 lb $2.45

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1937	1938	1937	1938	1937	1938
January	44.913	44.750	20.734	19.895	490.670	499.895
February	44.750	44.750	20.083	20.159	489.307	501.722
March	45.130	44.446	20.677	20.088	488.412	498.394
April	45.460	42.750	20.740	18.880	491.524	498.046
May	45.025	42.750	20.346	18.731	493.835	496.673
June	44.818	.....	20.022	.....	493.404	.....
July	44.750	.....	19.986	.....	496.582	.....
August	44.750	.....	19.848	.....	498.043	.....
September	44.750	.....	19.889	.....	495.145	.....
October	44.750	.....	19.942	.....	495.395	.....
November	44.750	.....	19.707	.....	499.467	.....
December	44.750	.....	18.835	.....	499.510	.....
Year	44.883	.....	20.067	.....	494.275	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		Electrolytic (a)	
	1937	1938	1937	1938	1937	1938	1937	1938
January	12.415	10.198	12.112	9.908	51.497	41.387	56.288	45.387
February	13.427	9.775	13.828	9.525	59.225	39.597	64.013	43.563
March	15.775	9.775	16.590	9.496	72.339	39.772	76.167	43.582
April	15.121	9.775	14.692	9.443	62.506	39.306	66.614	43.408
May	13 775	9.375	13.999	8.801	61.118	36.668	63.684	40.852
June	13.775	.....	13.492	.....	55.696	.....	61.409	.....
July	13.775	.....	13.817	.....	56.412	.....	62.807	.....
August	13.775	.....	13.926	.....	57.143	.....	63.595	.....
September	13.530	.....	12.984	.....	52.989	.....	58.966	.....
October	11.838	.....	11.207	.....	45.384	.....	50.619	.....
November	10.797	.....	9.850	.....	39.321	.....	44.023	.....
December	10.006	.....	9.714	.....	39.946	.....	43.886	.....
Year	13.167	.....	13.018	.....	54.465	.....	59.339	.....

New York quotations, cents per pound. London, pounds sterling per long ton, (a) Bid quotation.

LEAD

	New York		St. Louis		London			
	1937	1938	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	6.000	4.870	5.850	4.720	27.272	27.150	16.135	16.253
February	6.239	4.632	6.089	4.482	28.319	28.328	15.402	15.525
March	7.190	4.500	7.040	4.350	33.027	32.979	15.992	16.075
April	6.175	4.500	6.025	4.350	26.014	25.878	15.579	15.623
May	6.000	4.400	5.850	4.250	24.000	23.891	14.210	14.376
June	6.000	.....	5.850	.....	22.878	22.759	.....	.....
July	6.000	.....	5.850	.....	23.932	23.703	.....	.....
August	6.452	.....	6.302	.....	22.606	22.670	.....	.....
September	6.400	.....	6.250	.....	20.990	21.044	.....	.....
October	5.740	.....	5.590	.....	18.259	18.318	.....	.....
November	5.033	.....	4.883	.....	16.706	16.714	.....	.....
December	4.875	.....	4.725	.....	15.905	15.994	.....	.....
Year	6.009	.....	5.859	.....	23.326	23.286	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits, New York		Standard, Spot, London	
	1937	1938	1937	1938
January	50.925	41.548	229.350	183.619
February	52.010	41.373	233.750	183.144
March	63.043	41.219	282.988	183.473
April	59.172	38.430	267.136	168.612
May	55.651	36.885	250.645	162.693
June	55.851	.....	249.852	.....
July	59.245	.....	263.540	.....
August	59.465	.....	264.595	.....
September	58.675	.....	258.943	.....
October	51.654	.....	223.869	.....
November	43.299	.....	190.477	.....
December	43.051	.....	190.449	.....
Year	54.337	.....	242.133	.....

New York quotations cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	5.847	5.000	21.153	21.281	14.994	15.173
February	6.465	4.813	25.122	25.322	14.408	14.589
March	7.381	4.417	33.188	33.405	14.364	14.477
April	7.010	4.141	26.216	26.344	13.729	13.919
May	6.750	4.042	23.092	23.365	12.682	12.869
June	6.750	.....	21.409	21.528	.....	.....
July	6.923	.....	22.568	22.693	.....	.....
August	7.192	.....	24.140	24.290	.....	.....
September	7.190	.....	21.406	21.607	.....	.....
October	6.085	.....	17.722	17.955	.....	.....
November	5.630	.....	15.808	15.970	.....	.....
December	5.010	.....	15.274	15.429	.....	.....
Year	6.519	.....	22.258	22.432	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pounds sterling per long ton.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1937	1938	1937	1938
January	90.000	117.500	19.500	20.000
February	90.000	117.500	19.500	20.000
March	101.667	117.500	20.000	20.000
April	105.000	102.500	20.000	20.000
May	105.000	102.500	20.000	20.000
June	130.962	.....	20.000	.....
July	142.500	.....	20.000	.....
August	142.500	.....	20.000	.....
September	142.500	.....	20.000	.....
October	142.500	.....	20.000	.....
November	142.500	.....	20.000	.....
December	132.888	.....	20.000	.....
Year	122.335	.....	19.917	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound, average of producer's and plater's quotations.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1937	1938	1937	1938	1937	1938
January	14.130	13.750	90.250	79.240	50.400	36.000
February	14.563	13.750	91.000	76.455	64.364	36.000
March	16.375	13.750	91.778	72.444	58.000	36.000
April	16.043	13.654	92.000	71.019	58.000	36.000
May	14.830	12.460	95.520	74.640	54.800	33.400
June	14.702	.....	96.654	.....	53.000	.....
July	14.803	.....	93.904	.....	50.115	.....
August	15.327	.....	91.423	.....	51.000	.....
September	16.555	.....	89.020	.....	51.000	.....
October	16.935	.....	86.140	.....	48.560	.....
November	15.848	.....	83.435	.....	43.652	.....
December	14.144	.....	81.038	.....	38.385	.....
Year	15.355	.....	90.180	.....	51.773	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1937	1938	1937	1938	1937	1938
January	21.50	24.50	20.50	23.50	21.00	24.00
February	21.50	24.50	20.50	23.50	21.00	24.00
March	24.20	24.50	23.20	23.50	23.70	24.00
April	24.50	24.50	23.50	23.50	24.00	24.00
May	24.50	24.50	23.50	23.50	24.00	24.00
June	24.50	.....	23.50	.....	24.00	.....
July	24.50	.....	23.50	.....	24.00	.....
August	24.50	.....	23.50	.....	24.00	.....
September	24.50	.....	23.50	.....	24.00	.....
October	24.50	.....	23.50	.....	24.00	.....
November	24.50	.....	23.50	.....	24.00	.....
December	24.50	.....	23.50	.....	24.00	.....
Year	23.975	.....	22.975	.....	23.475	.....

Iron in dollars per long ton. F. o. b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

T. Haden has left Morro Velho, Brazil, and has gone to Redcar, Yorkshire, England.

John M. Carpenter is now with the Atok-Big Wedge Mining Company, Baguio, Philippine Islands.

Boudinot Atterbury, of New York, has been elected president of Consolidated Coppermines Corporation.

S. A. Mewhirter, mining engineer of Denver, Colo., recently at San Antonio, Tex., has gone to Bogota, Colombia.

William J. Leek, Jr., formerly at Franklin, N.J., is now engineer for the Bertha Mineral Company, Austinville, Va.

A. M. Tweedt has returned to Oakland, Calif., from Sevier, Utah, where he was superintendent of the Annie Laurie mine.

L. S. Taylor, mining engineer of Pueblo, Colo., is with the Masbate Consolidated Mining Company, Rio Guanobatan, Masbate, P.I.

Robert A. Layfield, formerly with the Star Mining Company, Yakima, Wash., is now with the Howe Sound Mining Company at Holden, Wash.

Dr. H. C. Parmelee, editorial director of *Engineering and Mining Journal,* was on June 1 elected chairman of New York Business Paper Editors.

Charles A. Hopkins is now doing engineering and chemical work for the Reymert Mining Company, at Reymert Mines, Superior, Ariz.

The Hon. E. Rodriguez, Secretary of Agriculture, Commonwealth of the Philippines, was in New York in May, while visiting the United States.

Francis A. Thomson, assisted by **O. A. Dingman,** made an extensive examination of the Sunshine mine, in the Coeur d'Alenes, during April.

Leland W. Wemple, president of the Illinois Zinc Company, has removed his office from 332 South Michigan Ave. to 47th St. and Sacramento, Chicago.

Colonel W. T. Chevalier, vice-president McGraw-Hill Publishing Company, was on June 2 awarded the degree of doctor of engineering by South Dakota School of Mines.

Russell R. Bryan, Edward H. Wisser, and **John Payne, Jr.,** have recently announced the opening of a new firm of engineers in Manila under the name of Bryan, Wisser & Payne.

W. F. Shinners, formerly mine foreman with Cia. Minera de Maguarichic, at Maguarichic, Chihuahua, Mexico, has resigned from that company and is now at Redondo Beach, Calif.

Leo Gibbons, formerly general manager of Gold Mines of Papua, Ltd., Misima Island, Papua, is now manager of Consolidated Gold Mines of Coolgardie, Ltd., Coolgardie, W. A.

William E. Norden has left Mexico, where he was on the engineering staff of Cia. Minera de Real del Monte y Pachuca, and is now with the Carbide & Carbon Chemical Company, New York City.

Clyde H. Gardner, recently slime-plant operator with Inspiration Consolidated Company, is now superintendent of Keystone Mines, Chloride, Ariz., his mailing address being P.O. Box 1003, that city.

Allan F. McAskill recently returned to Australia from a trip to the United States and Canada, where he investigated the latest developments in copper smelting practice for Mount Morgan, Ltd.

H. L. Talbot, metallurgical engineer, formerly with the International Nickel Company of Canada, will on June 15 assume the position of mill superintendent at the property of Minas Matahambre, Matahambre, Cuba.

John K. MacGowan, formerly a partner with Guggenheim Brothers, has been made chairman of the board of directors of Auburn Automobile Company, Lycoming Manufacturing Company, and the Columbia Axle Company.

H. S. Sweet, mining engineer, has joined the staff of Roseklip Mines Company, Bodie, Calif., as general superintendent. He was previously manager of Cia. Minera de los Azules, S. A., Santa Barbara, Chihuahua, Mexico.

B. V. Barton has joined the staff of Clutha Development, Ltd. (a subsidiary of Placer Development), Sydney, N.S.W., as consulting mining engineer. Mr. Barton has been engaged in consulting work in Australia for many years.

Merle H. Guise, who has been examining lode and gold placers on west coast of Vancouver Island and at the new gold camp of Zeballos, is now looking over placer properties in the old Caribou district, and will soon return to his headquarters at Olympic Hotel, Seattle.

Stuart S. Pullar, of Morning Star (GMA) Mines, N.L., has gone to Fiji as a member of the metallurgical staff of Emperor Mines, Ltd. He will supervise the experimental flotation work now to be carried out on the Emperor sulpho-telluride ores in a pilot plant.

Stanly A. Easton, president of Bunker Hill & Sullivan Mining & Concentrating Company, Kellogg, Idaho, has been unanimously elected chairman of the Board of Governors of the Western Division of the American Mining Congress for the current year.

J. V. Claypool, of Hibbing, Minn., an assistant superintendent of mines in the Hibbing-Chisholm district for the Oliver Iron Mining Company, has been appointed assistant manager of industrial relations for the company. Mr. Claypool has been associated with the company since 1906.

Dr. H. Foster Bain left Alameda, Calif., on June 1 on the "Clipper" for Manila after spending three and a half weeks in the United States. Honorary membership in the Japan Mining Institute has recently been conferred upon him.

W. S. Boyd, vice-president of both Nevada Consolidated and Utah Copper, is in Santa Rita, N. M., where he has taken temporary charge of the Chino unit of Nevada Consolidated, following the death of the general manager, **Rone B. Tempest,** on May 7.

A. J. Abrams, mining engineer of Denver, Colo., is at Hurley, N. M., to act in an advisory capacity for the Chino unit of Nevada Consolidated during the installation of new Akins classifiers. Mr. Abrams, formerly superintendent of Climax Molybdenum Corporation, in Colorado, is now connected with the Colorado Iron Works.

Fred W. Roumage has returned to the United States from the Philippine Islands, where during the past year he started a hydraulic mine. He is now connected with the Nevada State Planning Board on an upstream storage project of the Carson River, in Nevada. His address is 800 Wheeler Ave., Reno, Nev.

H. A. Sawin, whose article entitled "Bucket Dredge Installed at Goodnews Bay, Alaska," appeared in the May number, has written in to say that the new dredge does not "replace" the dragline previously working the platinum-bearing sands in that area, as stated in the headline, but that the dragline mining operations are still being carried on, so far as he knows.

John C. Reed, geologist, United States Geological Survey, sailed from Seattle on May 3 for Chichagof Island, Alaska, where he will conduct geological examinations and investigate developed properties. Others from the Washington office of the Survey who will soon depart for Alaska include **Gerald Fitzgerald, F. H. Moffitt, T. W. Ranta, J. B. Mertie, Jr.,** and **Philip S. Smith.**

Glenn L. Allen, mining and metallurgical engineer for Union Management Company of Manila, designed and placed in operation the mine, mill, and surface plants of the Santa Rosa Mining Company, Inc., at Jose Panganiban, Camarines Norte, P. I. He is now in charge of the mine as general superintendent. The mill is a model flotation-cyanidation plant for the treatment of copper-bearing pyritic gold ore.

OBITUARY

Huntington Adams, a mining engineer long identified with notable enterprises and for many years a leading consultant in New York and in Mexico, as well, died in New York on May 17 in his 58th year. Mr. Adams had been active in mining developments in Mexico, Chile, and Bolivia, and was in the Government service of the United States

HUNTINGTON ADAMS

throughout the period of the Great War. He was a member of the American Institute of Mining and Metallurgical Engineers and of the Mining and Metallurgical Society of America. His home was at Block House, Greenwich, Conn. He is survived by Mrs. Elsie Baskin Adams, and a sister, Mrs. Seward Erdman.

Harold Newbold Lawrie, a consulting economist and an authority on gold and silver in their relation and importance in world economy, died in Washington, D. C., on May 20 at the age of 55. He was born in New York

HAROLD NEWBOLD LAWRIE

City and was an alumnus of Columbia School of Mines, of the class of 1905. Mr. Lawrie was formerly economic adviser to the United States Senate Commission of Gold and Silver Inquiry and author of the Gold and Silver chapter of "Mineral Industries" since 1928. He contributed numerous articles on gold and silver to technical publications, his reviews on Gold having been authentic and valued features of recent Annual Review numbers of *Engineering and Mining Journal*.

Harrison Souder, mining engineer and consultant of wide and distinguished experience, died at Duxbury, Mass., on May 31 at the age of 67.

Thomas F. Sutherland, Deputy Minister of Mines for Ontario, died at Toronto on May 29 at the age of 59.

William Hutchings, of Duluth, assistant superintendent of exploration for The Oliver Iron Mining Company, died at Eveleth, Minn., on May 11, aged 65.

William Frederick White, managing director and editor of *Mining Magazine*, of London, died in Bexhill on April 13 at the age of 74.

I. E. Haight, a mining engineer of Montclair, N. J., was instantly killed in an auto crash 75 miles north of Belleville, Ont., on May 11.

Rone B. Tempest, for the last six years general manager of the Chino branch of the Nevada Consolidated Corporation, operating at Santa Rita and Hurley, N. M., died from a self-inflicted bullet wound on May 7 at the age of 58.

John Warrick died at Perth, W.A., on March 24, aged 72 years. After being associated with the Great Boulder Proprietary Gold Mines, Ltd., Kalgoorlie, W.A., for 40 years, he retired about three years ago from the position of general manager of the company.

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Letters

Philippine Government Denies Unsympathetic Attitude Toward Mining Industry

The Editor:

I HAVE THE HONOR to enclose herewith my reply to an article of Mr. Ralph Keeler of the *Manila Daily Bulletin*, which was published in your issue of February, 1938, under the caption of "The Philippines," and head phrases "Year Prosperous, With Gold Output Higher. Possibility Of Interference By Government Disturbing. Outlook Otherwise Bright."

In the interest of truth and in fairness to the Commonwealth Government of the Philippines, it is respectfully requested that the enclosed answer be given a space in your publication.

QUIRICO A. ABADILLA
Director, Bureau of Mines.

Manila, P. I.
April 1, 1938

Mr. Ralph Keeler
c/o Manila Daily Bulletin
Manila

Dear Mr. Keeler:

I have read with interest your article in the *Engineering and Mining Journal* of February, 1938.

For the guidance of this Office, I should like to be enlightened as to what Government interference is feared by the mining companies, because I am not aware of any plan of the Government to interfere in their operation.

You refer also to a certain power given by the new mining law to the Government to cancel any or all leases for real or fancied violation of the provisions of the mining law. This Office is not aware of any such power based on "fancied" violation. It is to be regretted that such unfounded statement which may discredit the good intention of the Government, should find its way into the press.

With regard to the statement that the Government will do all it can to prevent the granting of leases to American and foreign locators, it may be said that so far the Government has not done anything which should inspire such fear. This is again a statement of an unfounded fact which does no good to anybody but on the other hand may unnecessarily create an ill feeling amongst the Americans, against whom our people harbor no grudge or discrimination. It may be stated, however, that the mining law clearly prohibits ownership of mining claims by foreigners, and in this word "foreigner" the Americans are not included.

Your assertion that many applications for patents were made but the final granting had been deliberately delayed is not true.

You have stated also that the Government is empowered to impose any regulation whatever. It is needless to state here that the Government can not and will not promulgate, much less impose, any regulation contrary to the provisions of laws or the spirit of justice and reason. Your sweeping statement therefore is quite unfair and malicious.

You said also that the Commonwealth Government's attitude during the first period has been anything but sympathetic to mining. This could not be true, for as a matter of fact the new mining law approved by the Government is more liberal than the old one, in the manner of location of claims as well as in taxation. You also mentioned that operators are worried chiefly about what may be done to injure the industry rather than by what has been done. This again is an unfair statement, and I do not believe that you can specify any action which the Government has done to injure the mining industry. Of course, I do not believe that the Government should endeavor to encourage to go into mining in this country recalcitrant individuals or companies, foreigner or local, who see nothing but ill omen in every act of the Government.

It is believed that nothing would scare foreign capital from coming to the Philippines so much as such malicious articles as you have contributed to the *Engineering and Mining Journal* of February, 1938.

In the interest of truth and in fairness to the Government, it is hoped that you will withdraw your charges in your article in the *Engineering and Mining Journal* of February, 1938, unless you can substantiate them.

QUIRICO A. ABADILLA
Director.

Manila, P. I.

What Metal Statistics Show

PRODUCERS OF BASE METALS believe that a realistic, constructive measure taken to curtail mine output sharply during the summer months will result in a healthier situation for operators and employees later in the year, when business conditions are expected to show some improvement. The continued depressed business situation has shut off demand for metals for many months with a consequent result of seriously jeopardizing the statistical position of copper, lead and zinc. Announcement was recently made that copper production was suspended at the Mount Consolidated and Belmont mines of the Anaconda Copper Mining Company. A similar step was taken by the Mountain City Copper Company, in Nevada, and the Walker mine, in Calif. Operations at Utah Copper will be suspended for at least a month beginning June 16 and the Kennecott Copper Corporation has announced suspension of production at copper mines in Ely, Nev.; Ray, Ariz;. and Santa Rita, N. M. Lead producers in Missouri and Idaho are working on a reduced basis and many zinc mines in the Tri-State area have been forced to shut down due to the low price of zinc.

Following is a summary of the March and April statistics of the Copper Institute, in short tons, covering foreign and domestic operations:

	March	April
Production (blister):		
U. S. mine	43,553	41,698
U. S. scrap, etc	12,646	8,913
Foreign mine	95,939	91,267
Foreign scrap, etc	9,660	13,129
Totals	161,798	155,007
Production refined:		
United States	61,117	55,749
Foreign	108,704	106,839
Totals	169,821	162,588
Deliveries to customers:		
Domestic	33,434	31,684
Foreign	125,269	129,577
Totals	158,703	161,261
U. S. exports of domestic copper	11,142	11,187
Stocks refined:		
United States	342,785	355,663
Foreign	197,467	185,916
Totals	540,252	541,579

Production of blister copper for April totaled 50,611 tons, of which 41,698 tons was mine output and 8,913 custom intake. Domestic stocks increased 12,878 tons, bringing the supply at refineries, on consignment, and in Commodity Exchange warehouses to 355,663 tons, the largest since the end of 1934. Domestic deliveries to customers in April were 31,684 tons, against 33,434 tons in March. Actual consumption of copper, however, averaged 40,000 tons for March and April. Exports of domestic copper were again in good volume, totaling 11,187 tons in April.

▶ZINC—The April and May statistics of the American Zinc Institute, covering all grades, are summarized as follows in short tons:

	April	May
Production	38,035	37,510
Production, daily rate	1,268	1,210
Shipments	20,806	24,628
Stock at end	135,238	148,120
Unfilled orders	27,069	23,444

Statistics of the Prime Western division, common grades only, for April and May, follow:

	April	May
Stock at beginning	49,001	58,079
Production	20,868	20,537
Shipments	11,790	13,949
Stock at end	58,079	64,667

▶LEAD—The statistics for March and April, in short tons, are summarized as follows:

	March	April
Stock at beginning	138,134	143,511
Production:		
Domestic ore	35,129	37,997
Secondary and foreign	1,307	1,294
Totals	36,436	39,291
Domestic shipments	31,052	25,952
Stock at end	143,511	156,715

Quicksilver Production in 1936 and 1937

Production of quicksilver in the United States during 1936 and 1937 by states, according to the United States Bureau of Mines:

	1936			1937		
	Producing Mines	Flasks of 76 Lb.	Value (a)	Producing Mines	Flasks of 76 Lb.	Value (a)
Arizona	(b)	(b)	(b)	3	37	$3,337
California	51	8,693	$694,744	54	9,743	878,624
Nevada	11	211	16,863	20	198	17,855
Oregon	13	4,126	329,750	14	4,264	384,527
Utah	1	25	1,998	..	.....	.....
Other states (c)	11	3,514	280,839	10	2,266	204,348
Totals	87	16,569	$1,324,194	101	16,508	$1,488,691

(a) Value calculated at average price at New York. (b) Included under "Other states." (c) Includes Arkansas, Texas, Arizona, and Washington in 1936; and Arkansas, Texas and Washington in 1937.

Manganese Ore Industry in 1937

(United States Bureau of Mines)

The unprecedented demand for manganese ore in 1937 was met chiefly by record imports. Ore containing 35 per cent or more of manganese shipped from mines in the United States last year amounted to 40,241 long tons, against 32,119 tons in 1936. The value of the domestic production in this classification was $1,062,399 in 1937, against $696,400 in 1936. Imports of ore containing 35 per cent or more of manganese totaled 911,922 long tons in 1937, valued at $10,451,602, against 813,365 tons in 1936, valued at $8,711,799.

Details of imports for domestic consumption are shown in the following table. In addition, 2,343 tons, containing 50 per cent manganese, were shipped here from Puerto Rico.

Country	35 Per Cent or More Manganese			10–35 Per Cent Manganese		
	Ore, Long Tons	Manganese Content, Long Tons	Value	Ore, Long Tons	Manganese Content, Long Tons	Value
Brasil	77,988	35,505	$597,413	.....	.....	.....
Canada	196	104	4,678	.....	.....	.....
Chile	398	191	4,803	.....	.....	.....
Cuba	122,937	56,385	2,185,800	.....	.....	.....
Egypt	.....	.....	.....	45,600	13,384	$172,173
France	95	48	18,703	.....	.....	.....
Germany	64	31	17,272	.....	.....	.....
Gold Coast	254,548	130,148	2,942,430	.....	.....	.....
India, British	70,380	36,523	679,232	.....	.....	.....
Netherland India	1,126	631	28,607	.....	.....	.....
Philippine Islands	.....	.....	.....	250	65	3,000
Union of South Africa	209	118	3,125	16,660	4,832	88,595
U.S.S.R.	383,951	186,737	3,959,955	.....	.....	.....
Other countries	30	14	9,584	.....	.....	.....
Total 1937	911,922	446,435	$10,451,602	62,510	18,281	$263,768
Total 1936	813,365	405,813	8,711,799	33,283	9,936	107,801

Stocks in bonded warehouses increased materially and at the end of the year amounted to 681,290 long tons, containing 340,475 tons of manganese.

CALIFORNIA

Contract Let for First Debris Dam Near Auburn

Completion will permit resumption of hydraulic mining on the North Fork of American River—Large gold placer area in Placer County to be exploited

▶ Resumption of hydraulic mining was brought a step nearer to realization when bids were opened recently by the California Débris Commission, a unit of the United States War Department, on the North Fork of the American River débris dam, about 5 miles northeast of Auburn. Among sixteen bids A. Teichert & Son, Inc., Sacramento, Calif., submitted the lowest at $345,987. The highest bid was $566,665. Construction of the new dam, which is one of four to be built, will involve 26,550 cu.yd. of foundation excavation and 28,000 cu.yd. of concrete. It will be of the concrete arch type, about 620 ft. long and 155 ft. above the bedrock foundation. Principal mines that will make use of the dam include the Mayflower mine group; Forest Hill; Paragon, near Forest Hill; Big Dipper; Iowa Hill; and Lost Camp, Blue Canyon.

▶ Plans to increase mill capacity from 100 to 200 tons a day are being considered by Mother Lode Central Mines, Inc., Charles J. Dilke, president, operating near Angels Camp. The company also has recently acquired two additional claims adjoining the mine, which are expected to be worked by open-pit methods, increasing materially the tonnage of commercial ore now available.

▶ A 75-ton milling plant has recently been completed at the Defender mine, near Pine Grove, Amador County. About 35 men are employed under the direction of J. D. Bardill, manager.

▶ Work has been started on a 100-ton cyanide mill at the Crystal mine, near Shingle Springs, operated by New York interests, and milling operations are scheduled to start sometime in July. The contract was awarded to Mines Engineering & Equipment Company, of San Francisco, with O. J. Scherer Construction Company, Angels Camps, sub-contractor, carrying out actual construction. All plant equipment is being furnished by the Mine & Smelter Supply Company, of Denver. Operations at the mine are under the direction of Benoni Lockwood, Jr., with William A. Crowfoot, metallurgical engineer, supervising the mill construction.

▶ The zinc mine in the Walker Pass area near Kernville, Kern County, has been purchased by W. E. Trent, president, Whitmore Mines, Inc., Rosamond, from Terdevich and Basich, A. P. Lund, F. V. Keough, W. P. Moon, and Martin Nelson, all of Taft and Bakersfield. Several men are now deepening the 40-ft. exploratory shaft at the property, which carries heavy zinc sulphide ore in conjunction with lead, iron, and manganese.

▶ According to an announcement by J. D. Stewart, consulting mining engineer, Auburn, large-scale mining operations have been started at the Stewart gravel mines, in the Gold Run area, Placer County. The property is being operated by W. C. Riggs, of Tucson, Ariz., and a group of associates who plan to use the most modern excavating and washing machinery in the exploitation of the large yardage of gold-bearing gravel.

▶ Mining operations have been resumed at the Pioneer mine, near Plymouth, Amador County, after a shutdown of two years. Improvements planned include erection of a new headframe and a milling plant. Operations are directed by F. D. Barbarini, superintendent.

▶ L. F. Utter is considering early installation of a 10-ton mill at the Arctic mine, near Washington, Nevada County.

▶ Three engineering organizations, embracing the nation's outstanding civil, mechanical, and mining engineers, will meet at the Golden Gate International Exposition on San Francisco Bay during the week of July 10 to 17, 1939. Engineers' Day, sponsored by the San Francisco Engineering Council, will also be held on the 400-acre World's Fair site during the same week. The American Society of Civil Engineers, the American Society of Mechanical Engineers, and the American Institute of Mining and Metallurgical Engineers will hold their conventions in San Francisco during this period, with many events planned on Treasure Island, site of the World's Fair of the West. Exhibitors in the mining and engineering field will cooperate by holding special demonstrations during the convention.

▶ The Jumbo Consolidated Mining Company, operating the Mountain King mine, near Copperopolis, Calaveras County, recently signed a contract with the Western-Knapp Engineering Company for increasing the capacity of its 60-ton mill to 250 tons.

UTAH

Construction of Large Cyanide Plant at Mercur

Geyser Marion Gold Mining Company plans to raise capacity to 1,500 tons daily —Utah Copper suspends production

▶ On June 1, D. D. Moffat, vice-president and general manager of Utah Copper Company, announced that copper production, beginning June 16, would be suspended for at least a month. Reason for the shutdown is slack business and large stocks of copper. About 2,500 men will be put out of work.

▶ Announcement that the Geyser Marion Gold Mining Company, at Mercur, would immediately start construction of a cyanide plant with an initial capacity of 800 tons daily, and that the Horn Silver mine, at Frisco, had resumed operations, developed a more optimistic trend for mining in the Beehive State. Excavation for the foundations of the new plant at Mercur has been started, and General Manager F. B. Bothwell expects the mill will be in operation by next fall. Until the plant is enlarged to its ultimate capacity of 1,500 tons daily, the new and the old mill will be connected. Ore from the Geyser Marion open-cut mine and tailings from the old dump will be treated together with ore and tailings from the near-by Sacramento mine. Mr. Bothwell estimates that the company has a 30-year supply of milling material: 10,000,000 tons of ore averaging $2.50 a ton on the Geyser Marion and 300,000 tons of tailings containing $2.50 a ton in gold; 2,000,000 tons of $4 ore and 700,000 tons of $2.50 tailings on the Sacramento property.

▶ A crushing plant and a 7-ft. ball mill will be installed on the Sacramento ground. Ore and tailings will be reduced to slime pulp and be piped to the mill in a 5-in. pipe 3,500 ft. long. Another 5-in. pipe will be used to convey the barren solution up the hill. Two pumps at the mill will have a capacity sufficient to circulate 250 gal. a minute. A 100-ft. tunnel is being driven into the tailings dump and a raise will be made from the end of the tunnel. A conveyor system will be used to handle the tailings. The raise will serve as a bin for mine ore.

▶ Operations in the Horn Silver mine are carried on by leasers in three places. The main shaft has been reconditioned to the 300-ft. level. The Christopherson Leasing Company is developing a section of the mine, which has produced considerable gold ore. Manager Sidney B. Harman, in another lease, has a crew working a gold deposit in the Farnsworth tunnel. Tony Svalina is hoisting five tons of silver-lead ore daily from his 150-ft. shaft in a lease at the south end of the Horn Silver.

▶ Orders were given on May 17 to Superintendent A. P. Lofquist by the International Smelting Company to reduce operations at the Elton Tunnel, near Tooele, from a three- to a one-shift basis. The tunnel, now driven in the formation a distance of 6,100 ft., has developed 900 gal. of water per minute. The heading is still in an alluvial formation.

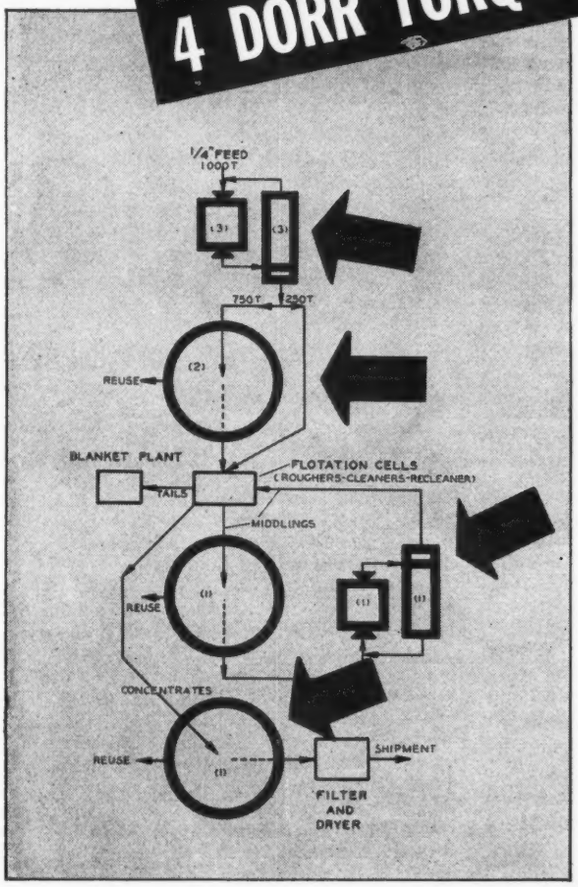
▶ A shipment of ore from the Pacific mine, in American Fork Canyon, netted the company $40 a ton for the 35-ton lot, according to N. J. Nielsen, vice-president and general manager. Within the last 90 days, Mr. Nielsen reports the company has shipped $10,000 of high-grade silver ore from a deposit developed below the 300 level. A vein, believed to be paralleling the Pacific vein, has been cut carrying values as high as 164 oz. of silver to the ton and 33 per cent lead.

▶ The Park Utah Consolidated Mines reported a net loss of $39,502.43 for the first quarter after depreciation but before depletion. Last year during the same period the company made a net profit of $128,692.

▶ Production of the New Park Mining Company at Park City has increased to the point where ore shipments, totaling 1,000 tons a month, are meeting the cost of development, according to the report of W. H. H. Cranmer, president and general manager.

For HOWE SOUND'S Chelan Mill

3 DORR FX CLASSIFIERS
4 DORR TORQ THICKENERS



THE NEW 1,000-ton flotation mill of Howe Sound Company's Chelan Division is treating the gold-copper ore of the Holden Mine. Located near Lake Chelan, fifty-two miles northwest of Chelan, Washington, this new mill is up-to-the-minute in every respect.

Important metallurgical steps handled by heavy-duty Dorr units at Chelan are as follows:

FINE CLOSED CIRCUIT GRINDING

3—Dorr FX Classifiers
7' wide x 25'6" long
Grinding to 65%—200 mesh

FLOTATION FEED CONDITIONING

2—Dorr Torq Thickeners
22' diameter x 8' deep

MIDDLINGS REGRIND

1—Dorr Torq Thickener
50' Diameter x 10' deep
1—Dorr F Classifier
6' wide x 23'4" long

CONCENTRATE THICKENING

1—Dorr Torq Thickener
30' diameter x 10' deep

Chelan and Britannia are but two of several thousand classification and thickening jobs that it has been our lot to handle in the past 34 years. Somewhere along the line one of our men has probably had to solve the same problem that exists today in your mill. *Why not call in the Dorr Engineer in your district? Your obligation is nothing—your gain may be better mill operation.*

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ARGENTINA: Luis Fiore, Buenos Aires • SOUTH AFRICA: Edward L. Bateman Pty. Ltd., Johannesburg • BRAZIL: Oscar Taves & Co., Rio de Janeiro

ARIZONA

Production at Pilgrim Mine to Be Increased

Larger crushing capacity being installed for treating gold ore—Development work continues at Trench mine

▶ The new cyanide plant of the Producers' Mines, Inc., at the old Pilgrim mine, is handling about 230 tons of ore daily, and as soon as the new crushers are installed production will be increased. The mill is also treating about 30 tons of ore daily from the Klondyke mine, 18 miles north of the mill. Robert A. Elgin is manager and M. C. Richardson consulting engineer.

▶ The development program at the Trench lead-silver mine, near Patagonia, will be continued, says R. B. Hatcher, division manager of the American Smelting & Refining Company, operating the property. Five or six months' development work is planned along with some diamond drilling.

▶ E. H. Tracy, of the Tracy Mining Company, Long Beach, Calif., is installing a new ball mill and a 50-hp. diesel engine on the Sultan property, near Hillside. There are ores in sight to keep the plant working for a year or more. A. T. Bohse is in charge of operations.

▶ The United States Machinery Company, of Twentieth St., Sacramento, Calif., has taken an option on the entire plant of the United Verde Extension Mining Company at Jerome.

▶ The Juan Olea property, near Hillside, has been taken over by a Nevada company and a mill is planned. Ben F. Snider is in charge of the work.

▶ Thomas Turner, Jr., and A. S. Johnson, in charge of operations at the Money Metal mine of the Yavapai Gold & Silver Mining Company, located in the Big Bug district near Prescott, plan sinking the shaft from the 400 to the 600 level.

▶ The Esperanza and Diamond Joe properties, east of Yucca and 50 miles from Kingman, in the Haulapai Mountains, are being developed by Ted Farley and J. T. Conger and associates, who recently took the property over from Ed. Hansen, the owner.

▶ The Pope mine, 20 miles north of Chloride, has a crew of men at work doing development work. Ross Barclay is superintendent for the Arizona-California Exploration Company, operating the property.

▶ The Tennessee-Schuykill Corporation, operating the old Tennessee mine, at Chloride, continues to ship a carload of concentrates, either lead or zinc, about every other day. The milling plant is making an excellent separation of the lead and zinc. Zinc concentrates are shipped to Amarillo, and lead concentrates to El Paso, Texas. About 4,500 tons of ore are mined monthly and the payroll carries about 130 men. The concentrates also carry gold and silver in commercial quantities. The mine has a depth of 1,600 ft., although no work is being done at the present time below the 1,400 level. R. L. D'Arcy is superintendent and Jacob Shoder is manager.

▶ S. E. Western and associates are producing approximately 700 tons of lead-silver ore per month from the Sunshine mine, in the Papago district near Tucson.

NEVADA

Prospecting Advances in Pinhook District

Development pushed on high-grade gold-silver outcrop found last year—Old Edgemont gold mine being reopened—Mountain City Copper shut down

▶ Eight claims in the old Pinhook district, west of Wellington, in Douglas County, on which gold-silver ore of high grade was found by prospectors last year, have been acquired under lease and option by John J. Raskob, whose two sons maintain an office and engineering staff in Reno. Ore from prospecting and development will be trucked to the 100-ton mill of the Sierra Consolidated Mines, Inc., just over the state line in California, a project controlled by Raskob in association with Reno men. The Raskobs are said to be negotiating for an option on property of the Mountain City Consolidated Copper Company, adjoining the Rio Tinto mine of the Mountain City Copper Company in northern Elko County. Low copper prices forced suspension of operations at the Mountain City Copper Company on May 27. About 150 men were thrown out of work.

▶ Operations of the Nevada Consolidated Copper Corporation at Ely will cease for at least a month beginning June 16.

▶ A 100-ton flotation mill completed lately near Beatty, Nye County, by the United States Milling Company, is treating gold ore from the Polaris mine, 6 miles distant at Rhyolite. Equipment includes one 100-hp. and two 50-hp. diesel engines, a ball mill, a classifier, a six-cell flotation unit, and two Wilfley tables. F. E. Nemic, president and manager, is preparing to add a regrinding and cyanide unit to treat the flotation concentrate.

▶ A dragline dredge is to be provided soon for the treatment of placer gravel near Sulphur, Humboldt County, where tests have indicated a profitable gold content. A large area at this point was acquired in December by the Wisconsin-Michigan Mining Company, including 1,360 acres optioned from Charles Crowder, of Sacramento. W. J. Popham, of Excelsior, Mich., is in charge.

▶ The old Edgemont gold mine, 15 miles southwest of Mountain City, in northern Elko County, is being reopened. The property was acquired lately under long-term lease and option of purchase by Ira B. Joralemon, engineer-geologist of San Francisco. George C. Spitzer, of Whiterock, Nev., is superintendent.

▶ Large bodies of mill ore of profitable grade are indicated by development work of the Winnemucca Mountain Mines Company, 3 miles north of Winnemucca, Humboldt County. A new tunnel was said to have crosscut low-grade gold-silver ore for a width of 45 ft. Gus Rogers, of Winnemucca, is directing development work.

▶ A new orebody opened in the Tonopah Divide mine, in Esmeralda County, is yielding gold ore for smelter shipments, according to E. J. Erickson, manager.

▶ In the Federal District Court at Carson City an order has been issued postponing until June 17 a hearing on the application of the Stone Cabin Consolidated Mines, Inc., for approval of its second amended plan of reorganization. The large mine properties, 400-ton flotation mill, and 500-ton cyanide plant in the northern part of the Como district, Lyon County, have been idle for around a year and in charge of a watchman.

▶ Old ore and tailing dumps at Tuscarora, Elko County, will be treated in a 50-ton cyanide mill, just completed. W. Harner, manager, expects to enlarge the plant and treat custom ores from Tuscarora and surrounding districts.

▶ Smelter returns on a basis approximating $2,000 per ton were received for a shipment of 3,000 lb. of gold ore trucked lately to a Utah smelter from the Western Duke group of claims near the high crest of the Gillis range in Mineral County, according to T. R. Pledge, of Hawthorne, owner of the property. From this ore rich specimens and small masses of free gold had been sorted and shipped to the San Francisco mint, yielding 26 oz. of gold. On its claims adjoining the Pledge ground on the east, the Champion Mining Company has completed installation of a gasoline hoist, a headframe, and other equipment and is driving a north drift from the bottom of its 105-ft. incline shaft and finding coarse free gold in a wide quartz vein. Similar coarse gold has been found at several points, mostly in narrow stringers of manganiferous quartz and calcite.

▶ Definite announcement has been made by A. E. Mosier, president of the Lucky Tiger-Combination Gold Mining Company, with headquarters at Kansas City, that his company will not rebuild the 50-ton cyanide mill at the Buckskin-National mine, in Humboldt County, operated for three years by the Lucky Tiger Company under a 50-50 lease, and that the lease has been relinquished. Forrest F. Bell, president-manager of the Buckskin-National Gold Mining Company, is carrying forward development work on a limited scale.

▶ With a crew of 45 men the Weepah Nevada Mining Company is mining and treating 300 tons of gold ore per day in its enlarged cyanide mill in Esmeralda County. The ore is mined from an open cut by power shovel and trucked to the mill. Weepah is now Nevada's largest producing gold mine, after having been virtually abandoned following a brief boom some twelve years ago. J. C. Perkins is manager, with office at Tonopah.

"Yours is a risky venture... storage batteries have no future"

SCOFFED AT IN 1888, EXIDE TODAY CELEBRATES FIFTY YEARS OF ACHIEVEMENT

FIFTY YEARS AGO, when The Electric Storage Battery Co. was formed, many business men were skeptical. Storage batteries, they said, were merely a laboratory experiment.

But critics were promptly silenced by the undeniable fact that the electrical industry was eager for these batteries. Street-car lines were among the first large users, installing battery-operated cars on many routes.

Today, Exides are used by railroads, steamship companies, and aircraft. They not only start our cars, trucks and buses, but their power is used to haul coal and ore underground, and to handle materials in industrial plants the country over. Exides operate emergency lighting systems in hospitals, schools, theatres, stores, and other buildings. Telephone companies, utility companies, radio stations and motion picture studios depend on these batteries for vital services.

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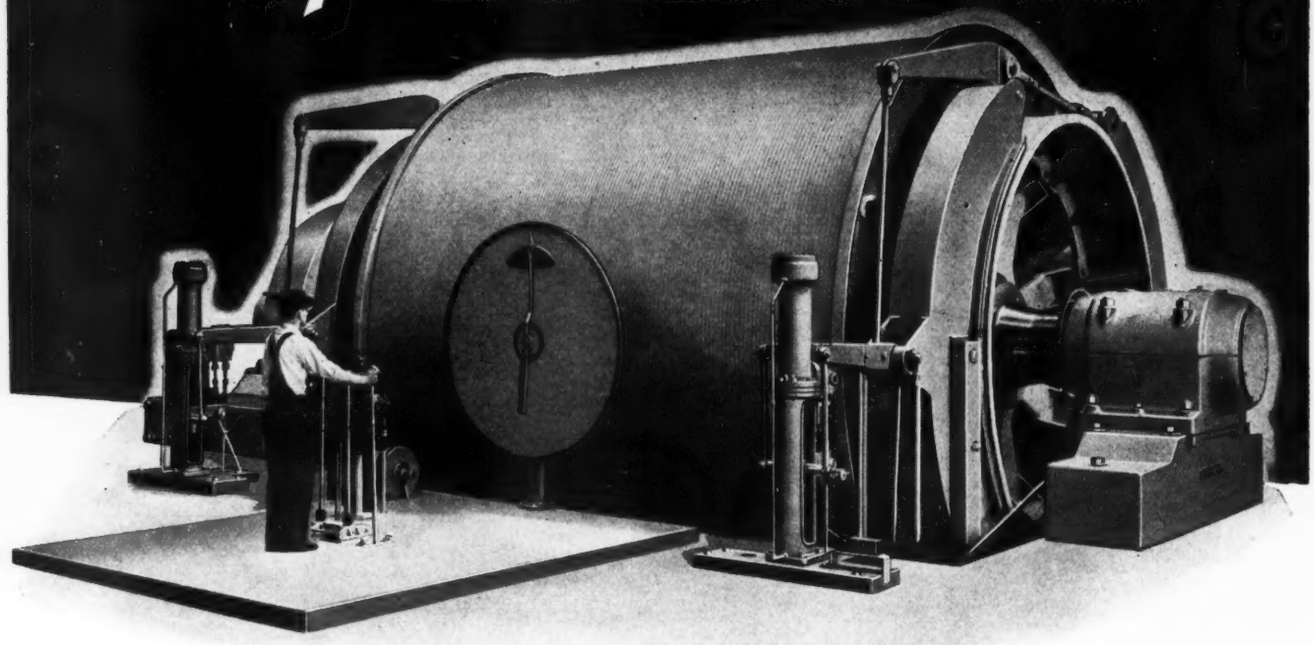
Another Record Hoist by NORDBERG



Tennessee Coal, Iron & Railroad Co.,
Ensley, Alabama.

Drum Diameter—18 feet
Drum Face—17 feet
Rope Diameter—1½ inches
Rope Length—7,450 feet
Weight of Ore—30,000 pounds
Weight of Skip—20,800 pounds
Motor Horsepower—2,500

Of the many unusual mine hoists built by Nordberg, this hoist ranks among the more outstanding. It is believed to be the largest single cylindrical drum, electrically driven hoist built in this country, if not in the world. The eighteen foot drum at each trip brings 15 tons of iron ore up a slope 6600 feet long at a maximum speed of 3600 feet per minute. The hoist operates out of balance and when lowering, returns current to the line by a system of dynamic braking. The two 13 foot diameter brakes work independently of each other, one brake having sufficient capacity to hold the full torque of the hoist. The design of drums, braking capacity, unusual system of controls and the various safety devices with which this hoist is equipped, all contribute in providing the utmost in safety and dependable performance. This hoist is just another instance where Nordberg has been entrusted with the solution of an unusual hoisting problem.

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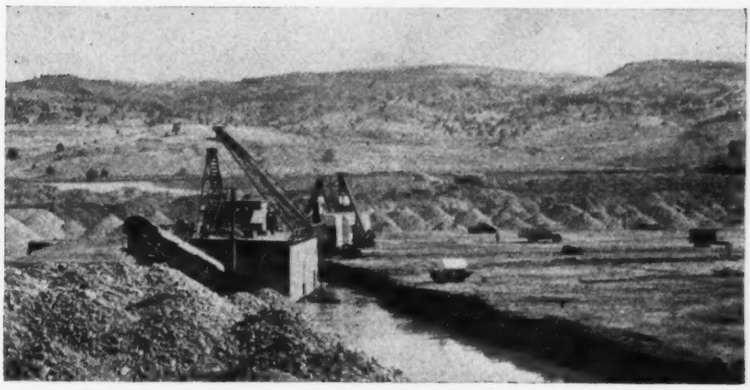

Placer operations in Oregon are getting under way for the 1938 season. Ferries and Marchbank, operating near John Day, wash about 6,000 cu.yd. of gravel per day, employing a 4½-cu.yd. Bucyrus-Monighan dragline

IDAHO

Active Placer Season for Central Idaho

Smaller streams expected to produce more gold with slump in employment—Low metal prices close Sidney mine

▶ Placer operators in central Idaho are getting ready for the biggest season in recent years. One of the major concerns is the Western Gold Corporation, which recently announced a series of transactions involving purchases of more than a quarter of a million dollars worth of properties. Officers are S. K. Atkinson, president; L. W. Thrailkill, vice-president; and Earl W. Murphy, secretary and treasurer, all of Boise. Through consolidation effected last winter, Western Gold Corporation has about 5,500 acres of mineral lands in Oregon, Idaho, and Montana, containing an estimated three and a half million dollars in gold.

▶ Polaris Mining Company has reelected James F. McCarthy, Wallace, president; L. E. Hanley, vice-president; Leo J. Hoban, treasurer; Bert Wooldridge, secretary; and A. W. Witherspoon. President McCarthy said the mine, the Coeur d'Alene district's newest silver producer, is operating on a six-day week basis with the mill treating 175 tons of ore daily mined from the 1,250 and 1,500 levels.

▶ Silver Syndicate has completed its registration with the SEC, covering 1,500,000 shares outstanding and 533,333 shares of treasury stock. The property joins the Sunshine and Polaris. Walter Palmer, of Kellogg, is president, and Donald Rogers, of Wallace, secretary.

▶ The mines of the Coeur d'Alene district set a new all-time record for net profits during 1937, with the eleven producing properties and operations of four leasers totaling $13,008,556. For the year 1936 the net profits amounted to $8,280,663. In the 1917 War period, $12,765,113 was reported, whereas in 1932 the combined total profits of all mines here amounted to only $441,610. Sunshine Mining Company produced more than half of the total, amounting to $7,157,761. Bunker Hill & Sullivan reported $1,914,922. Hecla was third with $1,542,938, and Morning mine fourth, with $1,466,069. The Crescent mine of the Bunker Hill Company reported net earnings of $364,105 and the Page mine turned in $385,761. The remainder was made by the Sherman, Dayrock, Jack Waite, Friseo, Blackhawk, and several leasers.

▶ The shaft at the Liberal King mine, on Pine Creek, has reached the 450-ft. station, according to Henry Weber, of Rose Lake, manager. A number of important stringers have been cut by the shaft, the last one nearly a foot in width and assaying 39 per cent zinc, 25 per cent lead, 10 oz. of silver, and 70c. in gold.

▶ J. L. Mercer, mining engineer, is reported to have obtained for the Snyder interests properties adjoining the North Star and Triumph mines in the Hailey district. The consideration was reported to be $125,000. Machinery will be installed and the old tunnel will be connected with the orebodies adjoining the famous Triumph workings.

▶ Custer Gulch Mining Company, operating in the Pine Creek district, will start an active development program this summer, according to Manager Ferring, of Spokane. An electric power plant will be installed and a deep crosscut will be driven to cut the vein.

▶ Sunshine Consolidated, in the Big Creek district, will start a diamond drilling program at once from the 1,700 level of the Jewell shaft of the Sunshine mine, according to Joe Hall, of Wallace, a director of the corporation. Contracts have been let for some 1,200 ft. of drilling. Frank Eichelberger, former manager of the Sunshine, is president of the Consolidated.

▶ Although more ore was in sight, and of a better grade, than at any other time in the history of the Sidney mine, in the Pine Creek district, the property was closed down early in May to await more favorable metal markets and a chance to mine on a capacity basis. Charles Brown, superintendent, reported disclosures of new ore reserves on the No. 5 and No. 6 levels.

▶ The Lone Pine mine, at Golden, is now producing gold ore that is treated in the remodeled mill, wherein amalgamation has been replaced by flotation. The property is operated under lease by Frank Holzheimer, Box 1832, Seattle, Wash., and Andrew McGregor and O. C. Thompson, of Vancouver, B. C. The report on page 95 of the February issue of *E. & M. J.*, stating that North American Mines, Inc., Boston, Mass., operating as the Gold Belt Mine Corporation, had purchased the property, is incorrect.

▶ Whitedelf Mining Company, operating at Clarksfork, has determined three orebodies, according to President Compton I. White, of Clarksfork. It is planned to sink the winze to the 500 level. Superintendent Iverson reported 4 ft. of milling ore and 12 in. of steel galena on the bottom of the footwall in the winze. Samples assayed 89.2 oz. of silver and 67.5 per cent lead.

▶ I. E. Rockwell, of Bellevue, was elected president of the Idaho Mining Association at a recent meeting in Boise. J. B. Eldridge, Boise, was elected vice-president; James Gwinn, Boise, secretary-treasurer; Stanly A. Easton, Kellogg; E. M. Norris, Conda; Frank Johnesse, Boise; R. E. Whitten, Idaho City; R. D. Leisk, Kellogg; Gordon C. Smith, Boise; Nate Pettibone, Grangeville; and Lloyd C. White, Stibnite, comprise the directors. The association opposed further suspension of the annual assessment work on unpatented mining claims.

SILVER PROJECT TO BE CONTINUED

AMERICAN SILVER Producers have decided to extend their research project to cover the period from June 1, 1938, to May 31, 1939. Based on the results of the past year's work, the project program has been modified so as to place the emphasis on the more promising developments. Applicability of silver for sliding electrical contacts, high-duty bearings, fungicides, special alloys, and clad metals is to be studied more intensively.

UNDER THE NEW arrangement all of the original sponsors and several additional silver-producing companies are supporting the project. Another research associate, S. V. Wilson, formerly with the Western Electric Company, has been added to the staff engaged on the silver research at the Bureau.

NEWS FROM Washington

By Special Correspondent

BUSINESS has not responded to Washington stimulus as the Administration leaders had hoped. This is politically serious. It means that more experiments are bound to be tried. Some of them will have to come rather soon in order to help the friends of the New Deal in primary battles.

As expected, Congress gagged a bit on the "Spend, lend, give away" program submitted by the Administration. But it was not easy to find any means for modifying it without creating difficulties for the opponents of the program, most of whom also have to think about primaries and final elections this summer and fall. The House could not even find any workable basis to suggest for earmarking the money which is to be allocated under the P.W.A. program.

It is that P.W.A. money which disturbs those who have not been regulars in support of reform. They know that it is the fund which can be used for support of those opponents who are more ardent New Dealers. Relief funds from W.P.A. will go where the relief is needed, not without political implications, but in fair relationship to the urgency of local demands. Loans from R.F.C. are granted or rejected regardless of the political significance.

Mineral Stockpile

SOME of the most powerful members of Congress and six of the executive departments got together on a program which is incorporated in a bill by Senator Thomas, of Utah, "to provide for the common defense by acquiring stocks of strategic and critical raw materials, concentrates, and alloys essential to the needs of industry for the manufacture of supplies for the armed forces and the civilian population in time of a national emergency, and for other purposes." This measure, S. 4012, was prepared by the cooperative effort of mineral specialists in the several executive departments who really know their business. It therefore lays a foundation on which a workable program can be carried through if Congress decides to pass the bill and appropriate the money. The funds authorized, $25,000,000 per year for four years, will set up sizable stocks of not only mineral strategic materials, but also non-mineral strategics, such as quinine, ipecac, and others, perhaps even including rubber.

To effectuate this policy, joint action of the Secretaries of War and Navy would be aided by the skilled assistance of representatives from State, Treasury, Interior, and Commerce. After suitable decision as to the quantity and quality of materials needed to meet industrial, military, and naval needs during a national emergency, the purchase would be made in conventional fashion by the Procurement Division of the Treasury. The commodities would be stored on military or naval reservations, to be used only in time of war on order of the President or when other national emergency would lead the Chief Executive to draw on these supplies to meet some important matter of national welfare. Under the proposed act, the purchases would give preference to supplies from domestic source to the extent of the present preference under the general purchasing policy. But the bill does not provide any waiver of requirements as to quantities or quality. Aid to domestic industry would be accomplished rather by development and research work to be done by the Department of Interior. (See a later section of these news columns.)

Responsible Administration

OLD-SCHOOL THINKERS held quite a celebration in Washington on May 2 when they heard the Supreme Court had reprimanded the Secretary of Agriculture for his administration of the Stockyards and Packers Act. But two weeks later when a 7-0 decision supported the National Labor Relations Board in the Mackay radio case there were groans from these same Old Guard quarters. It requires only moderately careful reading of these decisions to make clear the distinction which the Supreme Court makes between careless and proper administration of such laws by the executive agencies which are charged with quasi-judicial functions.

The Mackay case stated that in the early stages N.L.R.B. had failed to present the defendant with all of the details of proceedings, notably one of the examiner's reports. The Court also noted that subsequent proceedings of the Board made perfectly clear to the defendant the issues in the case. And the company was given full opportunity to justify the action of its officers as innocent, rather than discriminatory, if it could. Thus mere technicality of procedure is not going to govern the Supreme Court's findings.

In the Kansas City stockyards case the issue was quite different. The complexity and elaborateness of proceedings was not questioned, except possibly by implication that they were more burdensome than needful. But the Court found that in that case the party to the proceedings before the Secretary did not have clean-cut information as to what rates or what parts of the rates were to be acted on. He, therefore, was without adequate notice for the presentation of specific evidence pertinent to those particular matters.

Washington seems to think, therefore, that the Supreme Court will not quibble over mere procedural details, but that the Court will expect responsiblity for careful fair dealing by administration officials when they pass on matters vital to an industry or a company. It is hardly an oversimplification of the matter to say that the Court finds that responsibility for action goes along with authority to take action. Mining executives who have dealings with Federal officials can rightly assume a bit more considerate attention, but they should not presume any laxity or any rights based on mere technicality.

Strategics Research

PREPAREDNESS demands certain mineral stockpiles, but it also demands ability of the country to become self-sustaining with respect to every commodity, whenever a national military emergency continues for a long time. That is the basic philosophy on which a group of the executive departments have recommended to Congress that the proposed appropriations for strategic mineral stocks be supplemented by investigations of domestic supplies. The text of that proposal in S. 4012 (see also Stockpile item) is as follows:

Sec. 7. That the Secretary of the Interior, through the Director of the Bureau of Mines and the Director of the Geological Survey, is hereby authorized and directed to make scientific, technologic, and economic investigations concerning the extent and mode of occurrence, the development, mining, preparation, treatment, and utilization of ores and other mineral substances found in the United States or its Territories or insular possessions which are essential to the national defense or the industrial needs of the United States, and the quantities or grades of which are inadequate from known domestic sources, in order to determine and develop domestic sources of supply, to devise new methods for the treatment and utilization of lower grade reserves, and to develop substitutes for such essential ores and mineral products; to explore and develop, on public lands and on privately owned lands, with the consent of the owner, deposits of such minerals, including core drilling, trenching, test-pitting, shaft sinking, drifting, crosscutting, sampling, and metallurgical investigations and tests as may be necessary to determine the extent and quality of such deposits, the most suitable methods of mining and beneficiating them, and the cost at which the minerals or metals may be produced.

For the purpose of carrying out the provisions of this section there is hereby authorized to be appropriated, out of any money in the Treasury not otherwise appropriated for each of the fiscal years ending June 30, 1939, 1940, 1941, and 1942, the sum of $500,000, of which amount $350,000 shall be appropriated to the Bureau of Mines and $150,000 to the Geological Survey.

Phosphate Message

PRESIDENT ROOSEVELT says, "It is, therefore, high time for the Nation to adopt a national policy for the production and conservation of phosphates for the benefit of this and coming generations. To the end that continuous and adequate supplies be insured, and that efficient forms of this key element, phosphorus, be available at the lowest cost throughout the country, I recommend that a joint committee of the Senate and of the House of Representatives be named to give study to the entire subject of phosphate resources, their use and service to American agriculture, and to make report to the next Congress."

Thus the Western phosphate proposals of Senator Pope finally blossom in a recommendation that probably is intended to add to the political prestige of this loyal New Dealer during an

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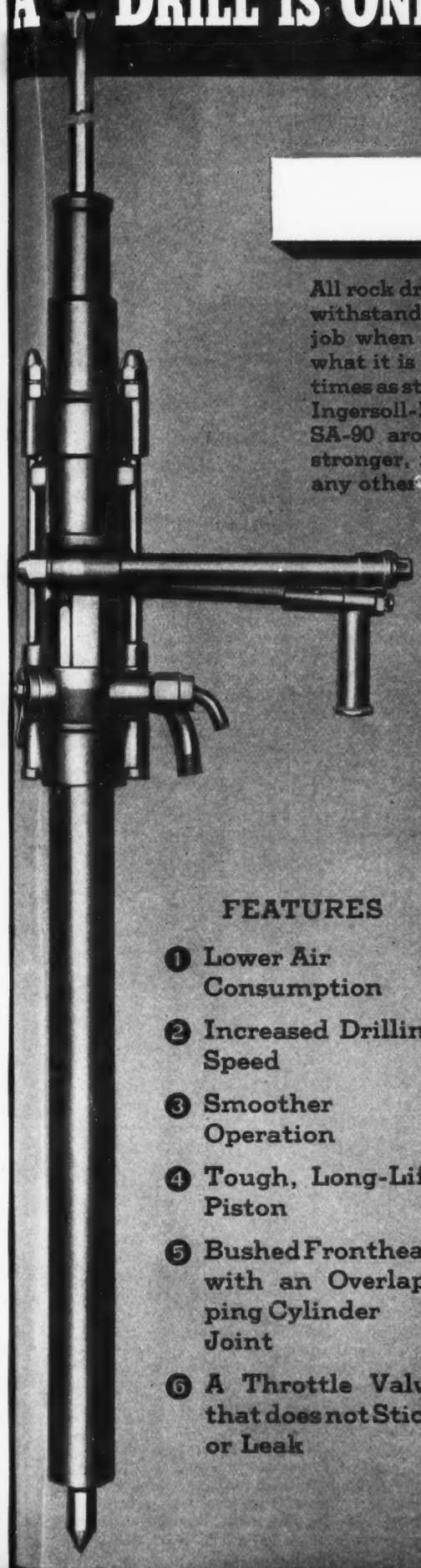

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election year. The earlier proposal that a big phosphate-processing plant be built in Idaho has been abandoned, at least for the present, lest such a magnificent enterprise, politically valuable this year, blow up to discredit its backers when it is found uneconomic. And, of course, this was no time for T.V.A. to branch out into virgin fields while its Valley activities are under fire.

It is likely that the investigation suggested by the President will be ordered because it will justify a pleasant Western trip for some of the members of Congress who can spare the time from fence repairing at home.

All this affair has large industrial significance, as well as political. It shows the present philosophy of Washington in relation to going industries. There is no hesitancy in executive circles in using any group or enterprise which has attracted public interest or favor, as a basis for further political exploitation. The whole thing is a Coney Island hall of mirrors. No matter how well proportioned a proposition may be industrially, there is always a handy political agency of distortion if any useful political purpose may be served. Furthermore, some of the mirrors are so arranged that they can make creatures which are queer looking in fact appear almost attractive before the public. The Administration sincerely hopes that the T.V.A. joint committee of Congress will prove that kind. But impartial observers doubt the possibility.

Monopoly Reasoning

CONGRESS will vote an anti-monopoly investigation as recommended by the President in his message of April 29. That communication, one of the longest the President has ever sent to Congress, was a studied, but somewhat sophomoric, treatise. The first five sections disclosed the Presidential reasoning, a sort of brief in defense of anti-monopoly effort. The sixth section set forth "a program," and the final paragraphs were a tirade against those who should venture to oppose, with a peroration of flag waving.

The philosophy of the President, here first fully disclosed, must be studied critically by industry which seeks to pursue lawfully mining or manufacturing on a large scale. It is extremely important for every business man to note the type of arguments from which law making is likely to proceed in Congress next year. The following, a much condensed summary of the President's communication, is not adequate; executives should get and read the full message, in fact must *study* it, to understand its numerous implications:

1. The growing concentration of economic power is proven by the large percentage of stock ownership and the profits received by a small number of individuals. It is no defense, according to the message, that large numbers of individuals own small parts of several companies, through a few shares of stock.

2. Financial control over industry, demonstrated by Part 1 of the message, is vicious—"That heavy hand of integrated financial and management control lies upon large and strategic areas of American industry. . . . The small business man is unfortunately being driven into a less and less independent position in American life. . . . Industrial efficiency does not have to mean industrial empire building. . . . Industrial empire building, unfortunately, has evolved into banker control of industry."

3. The decline of competition has serious effect on employment. This section also castigates "rigid prices and fluctuating payrolls,' for "Managed industrial prices mean fewer jobs." "Private enterprise left to its own devices becomes half regimented and half competitive."

4. Competition does not mean exploitation. Many competitive prices are now too low, notably agricultural prices. Federal wage and hour legislation is necessary to eliminate child labor, chiselling on wages, and other unsocial practices.

5. "The choice before us." Collectivism in industry compels collectivism in government, a continuation of the present claimed trend. The alternative is enforcement of free competition.

Out of this the President develops a program continuing the traditional anti-trust methods, but with modernization and amplication. He recommends:

1. Improvement of anti-trust procedure.

2. More rigid scrutiny of mergers and interlocking relationships.

3. Financial controls of investment trusts, bank holding companies, and related fiscal institutions.

4. Supervision of trade associations which will restrict their present monopolistic tendencies.

5. Amendment of the patent laws to restrict patent rights, virtually recommending unrestricted compulsory licensing.

6. Tax correctives, definitely intended to use tax methods for forcing industrial practice that would otherwise not be subject to Federal domination.

7. Creation of a Board of Industrial Economics, obviously outlined as a statistical agency with regulatory objective.

And finally for the critics the President says, "No men of good faith will misinterpret these proposals. . . . This program should appeal to the honest common sense of every independent business man. . . ." Those who disagree can see where they are classed.

FELDSPAR SUBSTITUTES

SEVERAL RECENT episodes in Washington have spotlighted the development of feldspar substitutes, especially in the field of nepheline syenite, which is brought in from Canada and ground in a new plant near Rochester, N. Y. The material, which is crushed and cleaned magnetically at its point of origin near Lakefield, Ontario, is finished in the United States because of tariff differentials. It finds its major market in the glass industry because of its high alumina content, nearly 25 per cent. Its content of alkali, from 10 to 15 per cent, is also favorable as a glass-making constituent. But the high ratio of alumina to silica gives its greatest advantage.

TO A MUCH MORE limited extent the Bureau of Mines reports that spodumene is also being substituted for feldspar, but one of the notable difficulties is the high iron content of many occurrences.

AS A RESULT of these technical developments there has been an effort on the part of the feldspar industry of North Carolina to protect itself against the Canadian imports. Representative Bulwinkle, of that State, has introduced a bill which would provide a tariff of $6 a ton. Several commercial interests were represented before the committee on tariff information when it was holding hearings regarding the Canadian trade agreement. But none of these developments indicate that any actual change in tax or tariff is likely to occur. The development represents, therefore, merely a logical intercommodity competition between minerals of identical possible applications.

News "Fines"

CANADIAN DEAL—The British and Canadian trade agreement negotiations must be handled together, especially for minerals. In a number of cases triangular deals are being made. In them Uncle Sam gets a concession from one of the British groups in return for a concession to the other. Numerous mineral questions are being settled that way, Washington hears.

Assessment Work—The perennial effort to relieve owners of mining claims of the required annual assessment work is in full swing. Though opposed officially, this request of the small miners can hardly be denied in an election year.

Wage Fixing — Minimum wages for the vitreous or vitrified china industry were fixed by the Secretary of Labor under the Public Contracts Act early in May. Madam Perkins confirmed the Board recommendation "that the prevailing minimum wage in the manufacture of vitreous or vitrified china can be found to be 42¾ cents per hour, or $17.10 per week for a week of 40 hours." Such decision has real significance for other mineral industries that may later be up for labor rulings. Confirmation of union wages may generally be expected.

Bank Loans—Officials think that some banks do not loan to industry as readily as they should. Hence it is now planned that the bank examiners be instructed to be more lenient in their scrutiny of loans in the portfolio of each institution inspected. Whether this will make conservative bankers any less careful with the money of their own corporation is doubtful.

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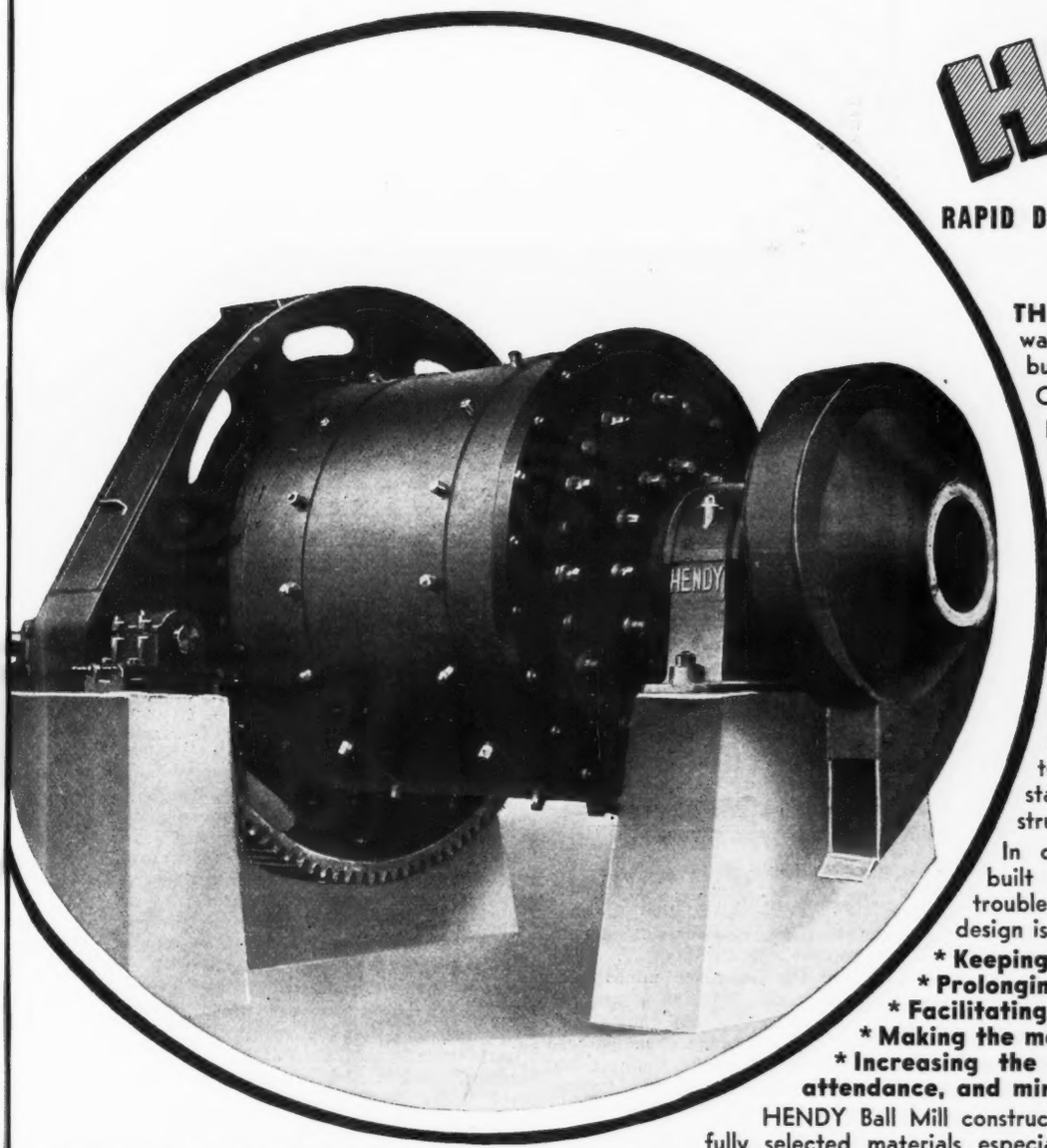

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COLORADO

Manganese Deposit Being Developed Near Silverton

Ore will be shipped to Pueblo—Platinum found in copper mine in La Plata district—Placer miners start 1938 season

▶ The Fairview Mining Company, under the local management of J. E. Castle, is developing a deposit of manganese ore on Sultan Mountain about four miles south of Silverton. A shipment of ore was made early in the winter to the Colorado Fuel & Iron Company at Pueblo, and was found to meet requirements. Shipments will be made daily to Pueblo when the property is further developed. Mr. Jackson, of the Jackson Chevrolet Company of Pueblo, heads the syndicate operating the property.

▶ E. T. Erickson, during a laboratory study of samples and specimens collected by Edwin B. Eckel in the La Plata mining district, found appreciable amounts of platinum and palladium in the copper-bearing ores. This Copper Hill deposit lies near the edge of a large mass of the igneous rock syenite, through which are disseminated chalcopyrite and other metallic minerals. Chalcopyrite also occurs as small, irregular veinlets and lenses. These samples, picked from the old dump, show equal amounts of platinum and palladium, with little silver present. Mr. Eckel states that selective sorting would produce a good grade of shipping ore. This property is at an elevation of 10,250 ft. and located about 20 miles from Durango.

▶ In the Leadville district activity is principally confined to the gold mining, with the McGaughan lease, on the Dolly B, continuing to ship a car of siliceous ore each week. Carl Youngstrom and associates, on the Ollie Reed, are shipping a car of lead carbonate ore weekly. Ellis Webster, on the Commerce, Harry Sundstrom & Company, on the Valley, and John Cortellini, shipping from the Ibex, Tribune, and Venir, now comprise most of the mining activity in this camp.

▶ The placer resources of East Tennessee Gulch will be exploited this season on a large scale, with the installation of modern machinery by S. J. Peterson of Fairfax, Mo., with J. B. Ball in charge of operations 5 miles north of Leadville. Lateral ditches are being dug to drain a large part of the swamp at the mouth of the gulch. A Link-Belt dragline, driven by a 175-hp. Caterpillar diesel engine, employing a 2½-cu.yd. bucket, will be used. The properties have been leased by Frank E. Kendrick, Jr., of Leadville, manager of the Triumph Gold, Inc.

▶ On the upper levels of the Climax mine a standard system of chutes and grizzlies for handling the ore has proved satisfactory, and in the main haulage level this system was replaced with a slusher system employing manganese steel scrapers made by the Vulcan Iron Works, of Denver. The system is reported to be cheaper in development and production costs, safer, and adaptable to changing mining conditions and equally as fast as the caving system using grizzlies and chutes.

▶ The Empire Zinc Company, under the supervision of I. A. Jones, continues mining silver-copper ore at Gilman, Colo.

▶ J. Fred Johnson, engineer for the American Smelting & Refining Company, states that the company has completed negotiations for a group of claims up Bear Creek Canyon on Gold Hill Mountain, and that as soon as the road is open machinery will be brought in and development started in the Old Fairview mines.

▶ Veta Mines, Inc., at Telluride, continue their development work and steady operation of the 400-ton mill. About ninety men are employed. Charles Glasgow is general superintendent.

▶ Work has been resumed at the Mineral Farm Mines, Inc., at Ouray, Colorado. A new ventilating system was installed in the main heading of the mine, in addition to all new equipment, according to William Cutler, manager.

Anselmo mine of the Anaconda Copper Mining Company in Montana is the only property of the company that is now producing copper. Mining is done below the 2,800-ft. level. The surface plants shown above were completed last year

MONTANA

Production at Butte Reaches Low Level

Anselmo mine only copper producer as two more mines are closed—Manganese ore being shipped from Emma mine—Heavy snows hamper gold miners

▶ Copper production at this time by the Anaconda Copper Mining Company is limited to operations at the Anselmo mine, as the Mount Consolidated and Belmont were closed May 27. The Steward and St. Lawrence mines were closed on May 5. No zinc mines are being operated directly for that metal, although a limited tonnage of manganese ore is being taken from the Emma mine, under lease to the Anaconda Copper Mining Company from the Butte Copper & Zinc Company. This manganese is being shipped to the Colorado Fuel & Iron Company in connection with its United States Navy contract to supply 5,500 tons of ferromanganese. Besides maintenance repair work, pumping, and general maintenance work, a limited amount of general development is being conducted in several of the non-producing copper mines of the Butte district.

▶ Outside of Butte, base-metal operations throughout the State are at a very low point. All operations at Phillipsburg are at a standstill, including all zinc, manganese, and silver production. Anaconda is continuing production from its silver-lead property, the Flathead mine, near Kalispell, and even though its contribution to the Flathead County labor and supply markets is relatively small, it is hoped that continuation on a limited basis may be possible. The Mayflower mine, a small producing gold mine of the Anaconda company, is relatively unaffected by the general curtailments throughout the State.

▶ Recalling the serious power shortage in Montana during last summer owing to lack of water, it would appear to be the irony of fate that the present winter's water resources have been above normal and that reservoirs have been adequately replenished to assure a period of heavy power delivery which it now appears may not be required. As an anticlimax to this, on May 17 a four-day record precipitation occurred throughout the Rocky Mountain watershed in Montana. Snow from two feet in Butte to more than four feet in the higher altitudes paralyzed transportation and communication to mines in a wide area, and placer operations of some operators will be late in starting. Broken transmission lines resulted in a complete tie-up of all Butte mines.

▶ The richest ore strike in 20 years in the Barker-Neihart district of Montana was reported from the Hughesville mining camp where Bill Thorson encountered a four-foot vein of ore reported to be

▶MONTANA

valued at $100 per ton. The strike was accidental as Mr. Thorson was digging a post hole to set a light pole at the rear of a store. A few feet from the surface he struck solid galena, picture rock that ran $70 in silver and $30 in lead per ton. He immediately secured a lease on the ground and has taken out one carload of ore valued at $4,000.

TRI-STATE

Slight Drop in Zinc Concentrate Output

More mines, mills, and re-treatment plants suspend operations—Heavy water flow struck in Garrett shaft

▶ Production of zinc concentrates in the Tri-State area averaged slightly over 6,100 tons for May, about 400 tons under April. There were 35 mills operating in May, five of which were tailings re-treatment mills and two treating a mixed feed of ore and tailings. The companies treating mine ores which shut down during the month were the Indian Mining & Royalty Company, Lavrion Mining Company, Little Phoebe Mining Company, and Miami Big Five Mining Company. The Atlas Milling Company shut down its tailings re-treatment mill, and the Lawyers Lead & Zinc Company shut down its mill, which had been treating mine ore and tailings. Lewis Milling Company has started up the old Black Eagle mill of the Eagle-Picher Mining & Smelting Company, to re-treat tailings.

▶ Tailings re-treatment mills have been hardest hit by the current depression because of the low tenor of the available tailings. Extraction is now under 1 per cent zinc sulphide. Practically no lead is recovered in tailings re-treatment operations, and often it is the lead content which enables mine mills to operate when the price of zinc concentrates goes too low for profitable operation.

▶ The closing of the mines of the Oronogo Mutual Mining Company has led the Eagle-Picher Mining & Smelting Company to close its mines in the Oronogo (Mo.) area and take off the Oronogo ore train carrying ore to its Central mill, near Commerce, Okla. Inability of many small companies to operate at present prices has forced Eagle-Picher to operate its Central mill on a part-time basis of three to four days per week.

▶ The Garrett shaft of Eagle-Picher had reached a depth of 426 ft. late in May. A total of 7,618 sacks of cement have been used so far for grouting to hold back the heavy flow of water. The shaft will be bottomed at 435 ft., and a drift will be cut out on the 430-ft. level to a drill hole 100 ft. southeast of the shaft. The shaft, which is the deepest in the district, will later be sunk to 460 ft. if future development work warrants.

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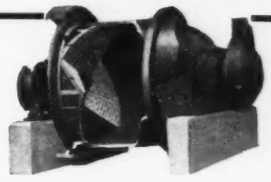

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IRON COUNTRY

Improvement Hoped for During Summer

Operators anticipate better demand for ore during July—Present rate of steel output requires about 2,000,000 tons of iron ore monthly

▶ The iron-ore mining industry is quiet at present. The rate of steel production, holding around 30 per cent of capacity, requires iron-ore consumption of about 2,000,000 tons per month. However, all operators are hopeful conditions will improve and that shipments will be heavier after July 1. No change has been made in the basic rate of labor, but time of working has been cut down to about three days per week for all men employed. Operators are doing everything possible to give work to married men and to the single men with dependents in order to keep as many men on the payrolls as possible.

▶ The Oliver Iron Mining Company is operating in the various districts on a two-shift basis, five days per week. This schedule is expected to be carried through until the end of the shipping season.

▶ The Inter-State Iron Company is operating at the Hill Annex Mine, Calumet, Minn., and the Grant Mine, Buhl, Minn., on a reduced schedule—three or four days a week at the Hill-Annex and two or three days per week at the Grant Mine.

▶ Pickands, Mather & Company started loading ore at the Mahoning mine on May 23, but no definite schedule is in progress. Other mines of Pickands Mather are now idle, but it is expected that several of these properties will start shipping next month.

MICHIGAN

Seneca Copper Property Sold at Auction

Peninsula Copper Company obtains mines and gives Calumet & Hecla a five-year option—Copper Range company curtails production

▶ In an attempt to cope with the present condition of the copper market and resultant low prices, salary and wage reductions have been put into effect by the Copper Range company, and every form of activity except straight mining and necessary development work has been either stopped or curtailed. So far in the current year, costs of producing copper at the mine have been substantially lower than the average for last year.

▶ Pursuant to an order of the United States District Court at Grand Rapids, Mich., entered on March 2, 1938, the assets of the Seneca Copper Corporation were sold at public auction at the Keweenaw County courthouse, at Eagle River. The only bidder was William K. Clute, of Grand Rapids, representing the Peninsula Copper Company, which was organized by the bondholders' committee, the bid being $190,000. The new company will give to the Calumet & Hecla Consolidated Copper Company an exclusive option to explore Seneca for a period of five years.

"Main Street" at Zeballos, British Columbia's new gold-mining camp on the west coast of Vancouver Island. Rich ore has been developed at the Privateer, Spud Valley, and other mines

CANADA

Zeballos District Has a "Wonder" Mine

New plant to be built at Privateer property may treat highest millheads in Canada—Yellowknife River area, in Northwest Territories, attracts prospectors

▶ With the return of spring on the west coast of Vancouver Island, British Columbia, development and prospecting operations have been resumed extensively in the Zeballos area, and the population of the new mining settlement has swelled to about 800. A mill of 75 tons' daily capacity is to be built immediately at the "Wonder" mine of Privateer Mines, according to the president, D. S. Tait, of Victoria. It is expected that millheads will be higher than at any other gold mine in Canada, although no accurate estimate is available. The mine has been opened at three levels, the 600, 900, and 1,000, and at the 900 it is understood ore was developed for a distance of about 750 ft. Between the 600 and 1,000 levels it is believed ore to the value of more than $3,000,000 has been indicated. Raises are now being driven to block out the ore, and another adit has been started at the 1,100 level. A quarter interest in the company and the control of operations is held by Connell Mining & Exploration Company, Ltd., of Toronto. The company's representative at Zeballos is G. S. McDonnell. The Connell company has also optioned a half interest in the B. X. group, at Zeballos, from the Farris syndicate. A shear carrying promising values has been opened on the surface for a distance of about 1,000 ft. The property adjoins to the west the Goldfield mine of Spud Valley Gold Mines, where a 50-ton mill is under construction. The Beano group, south of the B. X., has been optioned to Inspiration Mining & Development Company, of Montreal. At the Man-O-War mine, Zeballos, the main vein and a branch are being drifted upon at the second level in the direction of their convergence and the adjoining Privateer mine. Values are improving, and a sample from the main vein at 64 ft. from the crosscut assayed 0.86 oz. gold per ton. A promising surface showing has been found at Central Zeballos 100 ft. beyond the west tunnel face and on the far side of a shear zone, according to T. O. Bibb, manager. Drifting was resumed on completion of a camp and installation of a power plant.

▶ Bralorne Mines, Ltd., leading gold producer in British Columbia, is now searching for other properties to develop. This policy was approved at the recent annual meeting, although the company was never in a stronger position and the outlook is most promising. R. Bosustow is managing director. It is expected an additional supply for several more years will be developed this summer.

▶ A revenue of $2,187,953 was realized by Pioneer Gold Mines in the fiscal year ended March 31, 1938, and a profit of $847,866 was earned. Dr. H. T. James, managing director, estimates ore reserves at 568,488 tons, of an average grade of 0.422 oz. The company is conducting a search for new properties and has options in the Zeballos, south Vancouver Island, and Cariboo districts of British Columbia, and Yellowknife, in the Northwest Territories.

▶ The dredging possibilities of a 10-mile stretch of Williams Creek flats, between Jack of Clubs Lake and Barkerville, will be tested this summer by drilling to be undertaken by a California syndicate including the Yuba Consolidated in-

terests. Representatives of the syndicate, headed by E. B. Degolia, of San Francisco, recently visited the property.

▶ Two lode properties in the Barkerville Gold Belt of the Cariboo district were acquired recently for examination. Pioneer Gold Mines optioned the Bralco group of some thirty claims and fractions, adjoining to the southeast the Cariboo Hudson mine, where a 100-ton plant is now being installed, and J. E. R. Wood, of Vancouver, optioned the Gisco group, about six miles northeast of Cariboo Hudson.

▶ Granby Consolidated M. S. & P. Company accomplished a further reduction of costs in the first quarter of 1938, when the average was 7.83c. per pound of copper produced, compared with 8.06c. in the last quarter of 1937. In the first three months of this year, 6,695,654 lb. of copper was produced at Copper Mountain. A. S. Baillie is general manager.

▶ A 150-ton mill will be built this spring at the Gold Belt mine, at Salmo, according to H. Grattan Lynch, manager. To bring the property into production an advance of $200,000 will be made by North American Mines, Inc., of Boston, which already has invested about $340,000 in the company.

Northwest Territories

▶ A number of spectacular discoveries have been made in the past two years in the Yellowknife River area, Northwest Territories, and this season has marked a rush of prospectors in larger numbers than following the opening up of the Great Bear Lake district, about 200 miles farther north. The main Yellowknife camp, near the north shore of Great Slave Lake, is connected by an 80-mile tractor road with Gordon Lake, where Camlaren Mines has a shaft approximately 375 ft. deep. A 50-ton mill will probably be shipped in this summer. An orebody 200 ft. long averaging 1.25 oz. across 7.7 ft. was indicated last year by diamond drilling. Consolidated Mining & Smelting Company of Canada has been extensively prospecting the Yellowknife region for the last three years and has now completed a 100-ton mill at the Con mine. From the Con shaft development work will be done on the neighboring Ryan Gold Mines property, now under Smelters' control. Ore grade is understood to be exceptionally high on both of these properties. On the Negus Gold Mines ground, adjoining Con-Ryan, 1,800 ft. of ore has been developed in three veins. Sampling in one of the sixteen trenches gave 18 oz. across vein width. Sinking an incline shaft on the east vein has reached a depth of 120 ft. and channel samples at 3-ft. intervals show average gold content of $56 per ton for a width of 20 in. Drifting north and south on the vein at the first level is now in progress, according to latest word from A. E. Kipps, general manager. Machinery for a 50-ton mill is at the end of steel at Waterways, Alberta, ready for shipment to the property in June. Among several other active claim groups in the vicinity, the Yellowrex, adjoining Negus on the south, and Oro Plata's Meg property are both diamond drilling. On the Meg, exploratory work is concentrating on the extension of the structure that occurs at the Con mine of Consolidated Smelters, adjoining to the west.

Ontario

▶ New machinery for a mill of 75 to 100 tons' capacity has been moved to the property of Bilmac Gold Mines, West Shining Tree area, Ontario, and construction of the mill building is proceeding on schedule. A new 150-hp. diesel engine has been ordered and is to be delivered in June, with initial production expected in the following month. Mine manager is T. Geoffrey Woodcock.

▶ Berens River Mines, located in the Favourable Lake area of northwestern Ontario, is to be provided with a million dollars in cash for mill construction and development. Financing will be made possible through an increase in the company's million-share capitalization. Newmont Mining Corporation holds a controlling interest. Due to the remote location, 150 miles north of Red Lake, mine plans involve construction of a 1,600-hp. hydro-electric plant on the Duck River, 8 miles from the mine. A winter road is to be put through from Lake Winnipeg, in Manitoba, a distance of 180 miles. Plans are now being prepared for a mill of 225 tons' daily capacity, using cyanide, probably to be followed by the addition of flotation for the recovery of high-grade silver-lead concentrate. Production is expected to start in September, 1939.

▶ Canada's greatest gold producer, Lake Shore Mines, is expected to report reduced earnings at the end of the current fiscal year, June 30. Factors contributing to the drop would be the higher wage scale for employees, large investment in depth development, and a reduction of $3 a ton in gold recoveries since 1934. The first nine months of the fiscal year shows gold extraction of $16.16 a ton from a daily average of 2,445 tons treated. The bottom level at present is at 4,450 ft., where the south vein (No. 1) has been found to be wide and of high grade. Another year or two will extend mining operations to a new block of levels, as part of the broad program to push down to 7,000 ft.

▶ An energetic program of mine expansion is in hand at Red Lake Gold Shore by W. P. Mackle, resident engineer. Recommendations for exploration, based on a geological survey by Dr. J. B. Maudsley, are to be carried out in the hope of finding new orebodies similar to the main ore zone. Intensive depth development is also being undertaken.

Quebec

▶ McIntyre Porcupine Mines has been granted power rights in favor of its operating subsidiary, Belleterre Quebec Mines, by the Quebec Legislature. With the passage of a bill entitled "An Act to Encourage Mining Development in the Province," Belleterre receives the right to build a hydro-electric plant on the Winneway River and to use the generated electric power exclusively for the company's mining operations. There is a 25-year lease, with the government re-

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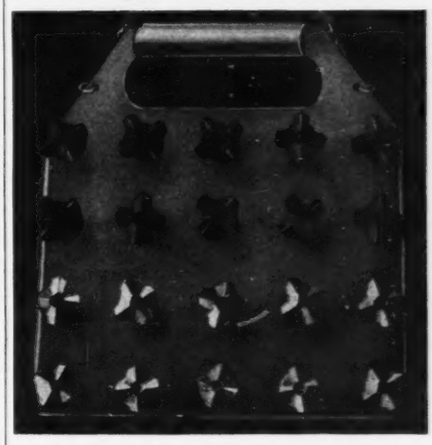

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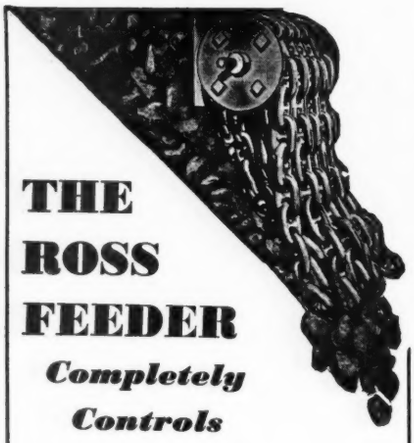

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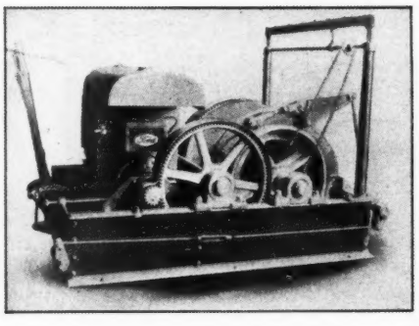

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▶CANADA

serving the right to buy back at cost. The dam site is within 13 miles of the mine. Initial capacity will be 1,500 hp., available in September, with provision for doubling the size as required. Costs are expected to be about $20 per horsepower. Belleterre's 125-ton mill was put into operation in August, 1936.

▶A second Quebec operation sponsored by McIntyre Porcupine is in the Malartic district, on a large property optioned from Amphi Gold Mines. This ground adjoins the north boundary of Sladen Malartic, where the new mill, rated at 600 tons daily, went into production last January. Diamond drilling in an area 1,000 ft. from the south Amphi boundary is exploring a greenstone-porphyry contact.

ALASKA

Mining Operations Start In Spring Rush

Labor supply held more than ample for season's requirements—United States Smelting, Refining & Mining Company will operate two new dredges

▶A new 3-cu.ft. dredge manufactured by Yuba Manufacturing Company, San Francisco, is being assembled for operations on Pedro Creek by the United States Smelting, Refining & Mining Company. The dredge will be electrically operated and operations are expected to start in June. The company also plans to start placer operations this summer on Cripple Creek with a Bucyrus-Monighan dragline having a 12-cu.yd. bucket. Roy B. Earling, with office at Fairbanks, is general manager and J. E. Hopkins assistant manager.

▶Mother Lode Coalition Mines Company plans to abandon its copper mine in the Copper River district, Alaska, as the life of the mine is extremely limited. The Securities and Exchange Commission recently removed registration and listing of the capital stock of the company, as requested by the company.

▶Placer operations will soon be started on Cripple Creek near Folger by Votila, Hard, and Hanson. A Northwest dragline having a 60-ft. boom and a 1½-cu.yd. bucket will be used.

▶Cleary Hill Mines Company, Cleary Hill, is having a geological survey made of its property by R. C. Gebhardt, mining engineer and geologist, who is a member of the exploration department of the E. J. Longyear Company, Minn.

▶Doro Mining Company has commenced operation of its new dragline unit on Nugget Creek, Lower Goldstream. One P. & H. and a Lima dragline with 1¾-cu.yd. bucket are being used. C. I. Paulsen, with office at Fairbanks, heads the company and Norman Ebley is engineer. About sixteen men are employed.

▶The Goodpaster district is reported to have its first ball mills installed. The Grizzly Bear mine, on Johnson Creek, will employ two Straub ball mills for grinding about 50 tons of gold ore daily. This operation is considered to be the first lode mine development in the Goodpaster district. Operators are C. W. Tibbett, of Fairbanks; the Tweiten brothers, Colvin Cripe, and Chris Ellinger.

▶North American Mines Company is prepared for dredging operations that will start soon at Jack Wade. The dredge with 4-cu.ft. buckets is operated by steam, but some time in the future diesel power may be adopted, because of the high cost of wood. Charles A. Whitney, at Fairbanks, is manager. About 25 men are employed. The company plans a dredging campaign this summer to prospect the Nome River on the Seward Peninsula. Thomas W. Thompson, at Nome, will be in charge of these operations.

▶The silver-lead mines at Mayo, Yukon Territory, are expected to maintain steady production this summer. Silver King, Elsa, and Hector mines, about 30 miles from Mayo, operated by the Tredwell-Yukon Company, are the largest producers. Ore is shipped to the Bunker Hill & Sullivan smelter at Kellogg, Idaho. A. K. Schellenger is superintendent.

▶Canyon Creek Placers Company will operate a new dredge this summer in the Kenai Peninsula district. H. W. Edwards is vice-president and manager.

▶Lucky Shot gold mine, in the Willow Creek district, one of Alaska's large producers, was recently sold to Canadian interests in Toronto, headed by Mr. Connolly.

▶Hirst-Chichagof Mining Company at Hirst, Chichagof Island, has started a drilling program on Krestoff Island. If results are satisfactory a mill may be installed late this year. Paul M. Sorenson is superintendent.

MEXICO

Base Metal Production Continues Steady

Labor disputes persist despite deepening of general business depression—Mercury-antimony ore produced in Guerrero

▶Mining in Mexico goes ahead moderately despite the general business depression, which is more of a crisis than paralyzation of industry and is not altogether attributable to the oil situation. Business is near a minimum; the situation is thought to be the culmination of events that started many months ago and which were aggravated by the oil question. Mine operators are following events in the petroleum situation very closely; but, at present, it does not appear that mining in the near future will experience the same fate as the oil industry. Late spring found developments and expansion of existing activities. There is slightly less labor trouble, albeit that headache still persists.

Buying of Mexican silver on the open New York market has been somewhat beneficial to Mexican mining. The Mexican Government plans to mint coins of 2.50- and 5-peso denomination with a higher silver content than money now circulating.

▶ There are fair exports of mining products, principally to the United States and Europe, though the foreign exchange situation is upset, as it has been since resumption of trading by private banks after a short suspension following expropriation of the oil companies, banks selling quotations ranging from 4.20 to 4.35 pesos per dollar and buying from three to eight points below those rates. There are reports the Bank of Mexico is endeavoring to peg the dollar at 4 or 4.10 to 1, compared to 3.60, the previous fixed rate. Reports from Mexico City state passenger and other communications in and out of San Luis Potosi are being maintained and mining companies in that region continue operations.

▶ Considerable work is being done by Cia. Minas El Cedro, Dudley E. Blaise, president and general manager, at its holdings near El Cedro, Guanajuato. R. M. Davidson, superintendent, has charge of the 130 workers. The company is arranging to improve its 175-ton mill and install more equipment.

▶ National Miners Union has started suit before the Federal Conciliation and Arbitration Board for 224,000 pesos (about $55,000) in behalf of workers of the Avalos unit, Chihuahua, of the American Smelting, who claim that sum as half pay for their recent strike.

▶ Tailings from its old dams are being treated extensively by flotation at the Cananea Consolidated Copper, Cananea, Sonora, Albert Mendelsohn, general manager.

▶ Cia. Minera de Maguarichic, S. A., is shipping ore at the rate of 20 tons daily from its properties at Maguarichic, Chihuahua, the manager of which is Eduardo Enriquez. The company has acquired much equipment from Cusi Mexicana Mining, which shut down last fall. About 500 men are employed.

▶ George S. Graham is providing his Mina Olga, El Boludo, Sonora, with conveyors and elevators. From 40 to 60 tons of ore, chiefly gold, are being treated weekly. Twenty men are employed under the direction of Firmine Garcia, mill superintendent, and Graham's assistant, Ricardo Cordero.

▶ About 150 tons of mercury-antimony ore are being treated daily at the 125-ton flotation plant of Explotadora de Mercurio de Huitzuco, S. A., Willard J. Moir, general manager, which operates at its holdings at Huitzuco, Guerrero, where 150 men are employed. Antimony is obtained by reducing the slag. John McLaughlin is mill superintendent and Kenneth Melcher is chief engineer. The company contemplates putting in more equipment and hiring more workers.

▶ Unwatering has been started at the old Desengano mine, near Guanacevi, Durango, by the Cia. Minera del Desengano, S. A., Erasmo Barraza, president and general manager, to permit development of gold-silver-lead-zinc ore. Gerardo Barraza is assistant general manager. About 190 men are employed.

▶ Exploration at the Soledad mine of the Cia. Minera Cibola, S. A., at Copalquin, Durango, has failed to find more ore, and present operations, confined chiefly to removing of ore pillars, are expected to cease permanently within a few months. The Cusi Mexicana Mining Company, directing operations of the mine just mentioned, made application to the New York Curb Exchange for delisting, which became effective May 6. The last annual report of the company advised that operations at Cusihuiriachic had been permanently discontinued.

SOUTH AMERICA

Cerro de Pasco to Build Electrolytic Zinc Plant

Initial production, expected to start in about two years, will be 100 tons refined zinc daily—Gold output reaches new high in Colombia

▶ Cerro de Pasco Copper Corporation, Lima, Peru, is contemplating capital expenditures amounting to several million dollars for new construction and equipment over the next few years. At the annual meeting of stockholders on May 11, President E. H. Clark said the company is developing a promising copper prospect at Yauricocha, Peru, where reserves of 450,000 tons of 9 per cent copper ore have been determined, and if 1,000,000 tons should be developed the company plans to construct an aërial tramway to the Central Railway of Peru, about 42 miles from the property. Mr. Clark said: "There are capital expenditures of about $7,500,000 ahead of us. This includes $1,800,000 for the second Cottrel recovery unit. Also included is $500,000 for increased hydro-electric power and $3,500,000 to $4,500,000 for construction of a zinc refinery and plant, which should be completed in two years. The Cottrell plant is expected to pay for itself within ten years. The zinc production is planned to start at about 100 tons of refined zinc daily." Construction will start when details of operating methods are worked out.

Copper production at the company's properties is running at a yearly rate of about 75,000,000 lb. Mr. Clark disclosed that about 10,000,000 lb. of copper of the 40,000,000 lb. imported into the United States prior to imposition of the 4c. tax remains on hand.

In 1937 Cerro de Pasco produced 75,094,065 lb. of copper, 42,005,290 lb. of lead, 9,881,827 oz. silver, 51,455 oz. of gold, and about 20,000 tons of zinc concentrates. Raymond Spilsbury is general manager at Lima, and Vernon L. McCutchan is assistant general manager at La Oroya, Peru.

▶ Compañia Minera Atacocha, S.A., located in Chicrin, in the Cerro de Pasco district, Peru, is treating complex silver-lead-zinc ore in the company's new 100-ton mill, that is brought from the

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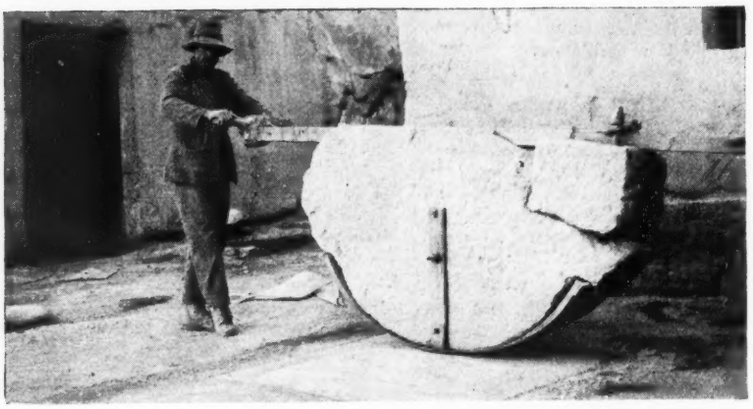


In the absence of modern streamlined equipment, this Bolivian miner uses a homemade concrete rolling weight to grind his small output of coarse tin concentrate

mine at Atacocha by a 2-mile aërial tramway. Crushing and grinding are done by a Universal jaw crusher, one 3-ft. Traylor gyrator crusher, and one 7x3-ft. Hardinge mill in close circuit with a Dorr type 6-ft. duplex classifier. Concentration is by differential flotation in eighteen Denver Sub-A machines. The ore treated averages about 5.9 per cent lead and 12 per cent zinc, and lead concentrates have about 72 per cent lead, 60 oz. silver, and less than 3 per cent zinc. Production of about 15 tons of concentrates is made daily.

Colombia—Recent statistics issued by the Bank of the Republic of Colombia show that gold production for the years 1932 to 1937 amounted to 2,014,781 fine ounces. This production is distributed by departments and districts as follows:

Antioquia	1,138,746	Huila	8,836
Atlantico	19,563	Magdalena	2,929
Bolivar	14,938	Narino	96,592
Caldas	171,521	Putumayo	3,854
Caqueta	189	Santander	10,748
Cauca	100,308	Santander Norte	138
Cundinamarca	554	Tolima	84,148
Choco	318,823	Valle	42,894
Total			2,014,781

Production in 1937 reached a new high, totaling 406,420 oz., compared with 388,739 oz. in 1936 and 328,991 oz. in 1935.

AUSTRALIA

Gold Production Shows Gain

West Australia produced more than one million ounces in 1937—North Kalgurli reports favorable mine development

▶ Richard Hamilton, in his presidential address to the West Australian Chamber of Mines, gave some interesting data relative to the gold-mining industry of that State. The following figures, abstracted from the address, show the changes that have taken place in the last few years consequent on the rise in Australian currency of the price of gold.

The table of gold production is given at bottom of page.

Mr. Hamilton recorded with pleasure the spirit of good will which had characterized the relations of capital and labor during the year, and particularly the cooperation of mine employees in effecting, with a minimum of friction, the most workable arrangements for the operation of the 40-hour week underground, in place of the 44 hours previously worked.

▶ There have been further favorable developments at the mine of North Kalgurli (1912), Ltd., Kalgoorlie, W.A. The N.E.D. lode has been proved to be of greater extent than originally expected and has now been located on Nos. 3, 5, 6, 11, 13, 14, and 15 levels. Several north and south lodes have also been cut in the exploratory work on other levels, and these will be investigated later.

▶ Latest quarterly report from the Moonlight mine of Gold Fields Australian Development Company, near Wiluna, W.A., shows good results with the treatment of 25,245 short tons of an average value of 6.33 dwt. per ton for a return of 7,004 oz., of which 767 oz. were in the form of antimonial concentrate and the remainder was bullion.

▶ The enlarged mill of Triton Gold, operating near Cue, W.A., has reached its rated tonnage of 9,000 monthly, a total of 9,309 tons being treated during March for the production of 3,053 oz. gold, an average of 6.5 dwt. per ton. Developments at the lower levels are proceeding satisfactorily.

▶ The reconstructed mill of Rothsay Gold Mines, N.L., Rothsay, W.A., commenced operations at the beginning of April. The mill, which is of 2,500 tons monthly capacity, employs strake concentration for the recovery of free gold, with flotation of the cupriferous strake tailings. The copper concentrate will be smelted in New South Wales. Ore averages 8.5 dwt. gold per ton.

▶ Interest at Bendigo, Vic., is being maintained by developments at the New Chum Syncline and South Virginia mines. At the 1,020-ft. level of the first-named mine both east and west backs of the Central Nell Gwynne reef (first cut in the shaft at 1,008 ft.) have been intersected, both showing visible gold; there is a spread of 50 ft. between the eastern and western limits of the formation. At the South Virginia, in the 490-ft. intermediate level, coarse gold is showing in a spurry formation 3 ft. wide.

▶ The New South Wales Department of Mines reports that mineral production of the State for 1937, valued at £15,526,465 Australian (approximately $62,000,000), showed the highest return since 1929. Gold output was 68,607 oz.

▶ Latest reports concerning the large dredge of Wellington Alluvials, Macquarie River, N. S. W., indicate that alterations and adjustments have been completed and that regular operation may now be expected. The exceptionally dry season has resulted in abnormally low river levels, which have contributed to retarding the attainment of capacity production.

▶ There was a steady expansion of the gold mining industry in Queensland during the year 1937, reports the Under Secretary for Mines, A. A. Staines. Discoveries at Bartle Frere (Mulgrave district) and Claudie River (Cape York Peninsula) gave a decided impetus to mining in those areas, and small parties and syndicates are active in many other districts of the North. Mill extensions at Mount Morgan and at Golden Plateau (Cracow) will help to swell the 1938 gold yield, which may reach 150,000 oz. Base-metal mining also showed expansion, the total value of the output being £3,337,734 Australian, an increase of £712,000 over the 1936 total. Principal development of interest in the base-metal field was the decision to equip the Return Creek tin property, Mount Garnet, with a large dredge capable of handling 350,000 cu.yd. monthly.

▶ Mount Charlotte, Kalgoorlie, W. A., reports ore reserves tentatively estimated at 1,120,000 tons averaging 5.36 dwt., in the northern section of its property. There is also a large body in the southern section, tonnage of which is as yet not estimated. Negotiations are in progress to obtain working capital for development of the mine.

▶ Gold Mines of Kalgoorlie's new mill

West Australian Gold Production

Year	Price of Gold (Australian Currency)	Tons	Yield, Oz.	Dwt. per Ton	Value of Yield, £A	Distributed as Dividends, Etc., £A	Wages, Stores, and Other Exp., £A	Number of Men Employed
1903	£4.25	2,160,657	2,335,425	21.62	9,920,248	2,024,152	7,896,096	20,716
1929	4.25	628,400	377,176	12.00	1,602,142	65,607	1,536,535	4,108
1930	4.46	645,344	417,518	12.93	1,864,442	31,250	1,833,192	4,452
1932	7.25	1,327,021	605,561	9.12	4,403,642	320,584	4,083,058	7,983
1934	8.53	1,772,931	651,338	7.35	5,558,873	991,275	4,567,598	12,523
1936	8.68	2,492,034	852,421	6.77	7,373,539	1,101,967	6,271,572	15,329
1937	8.73	3,039,608	1,007,289	6.62	8,797,660	1,213,529	7,584,131	16,174

has been placed in operation. The mill, which employs pre-cyanidation and flotation, is of 8,000 tons' monthly capacity and grade of ore treated is expected to average 8 dwt. J. Cornelius is metallurgist.

▶ Cuthberts Misima Gold Mine, operating on Misima Island, off the coast of Papua, north of Australia, treated 26,119 tons of ore during the year ended Dec. 31, producing bullion containing 7,407 oz. gold and 21,387 oz. silver. Operating costs totaled 29s. 11d. ($7.50) per ton, up 1s. 4d. per ton on the previous year, the increase being attributable to higher costs of stores and to dislocations caused by constructional activities associated with plant extensions.

Tasmania

▶ At the annual meeting of Mount Lyell Mining & Railway Company, which operates at Queenstown, Tasmania, the chairman announced the immediate enlargement of operations to one million long tons yearly. This will be accompanied by a further drop in the grade of ore treated, the object being to keep copper production steady at about 13,000 tons annually. Present ore reserves stand at 9,900,000 tons averaging 1.69 per cent copper, but the west Lyell open cut, which is now the principal source of ore supply, averages 1.44 per cent. Negotiations are in progress with the Tasmanian Government Hydro-Electric Power Commission with the object of securing a link-up with that system, in order to provide a standby source of power supply. Net costs for the year of producing and realizing one ton of copper were £47 12/- Australian currency (approximately 8.5c. per pound).

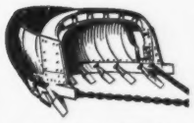
▶ Mount Lyell Company put a record tonnage of ore through its mill for the half-year to March 31, 482,473 long tons being treated for the production of blister containing 5,458 tons copper, 33,401 oz. silver, and 3,071 oz. gold. The grade of ore treated was about 1.3 per cent copper, compared with 1.67 per cent during the preceding year. A. H. P. Moline is acting general manager during the absence abroad of R. M. Murray, general manager.

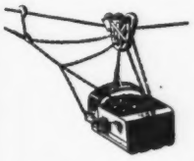
YUGOSLAVIA

Prospecting Suspended At Novo Brdo Mine

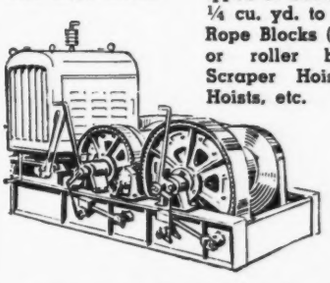
First results unsatisfactory as the ore so far developed is spotty—Zletevo new plant is ready for production

▶ Novo Brdo, one of the three properties in Yugoslavia controlled by the Selection Trust-Central Mining-Union Corporation group, has proved a disappointment. As only detached bodies of ore have been discovered, prospecting will be discontinued for the time being. The other two have developed into mines. Kopaonik shipped 13,093 tons of ore in April, from which was recovered 1,088 tons of 74.32 per cent lead concentrates averaging


Scraper Bucket


Slackline Bucket

"Durolite" All-Steel Wire Rope Blocks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In addition to the complete Sauerman machines, we offer also the various types of Sauerman buckets in sizes from ¼ cu. yd. to 15 cu. yd., "Durolite" Wire Rope Blocks (with either bronze bearings or roller bearings), Roller Bearing Scraper Hoists, Two Speed Slackline Hoists, etc.

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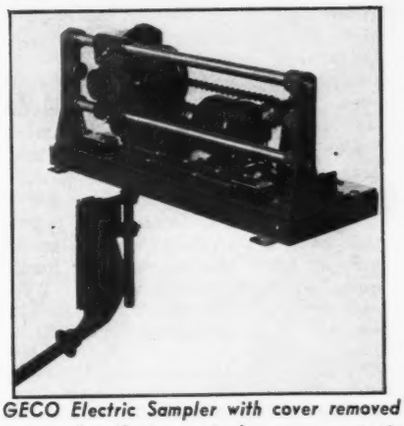
GECO Automatic Sampler


GECO Electric Sampler with cover removed

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▶YUGOSLAVIA

28.25 oz. of silver per ton, and 1,163 tons of 47.75 per cent zinc concentrates. Zletevo, its plant nearly completed, will begin producing almost immediately. There has never been any public offering of Novo Brdo shares, the three owning companies and a few of the friends of those controlling them having supplied all the considerable capital expended.

▶ Net earnings of Trepca Mines for the March quarter, after allowing for depreciation and Yugoslav taxation but before British taxation, was £68,889. On the deepest level so far developed, the 485 meter, the horizontal area of ore so far put in sight is 8,939 square meters and the average grade is 8.12 per cent lead, 3.49 per cent zinc, 0.17 per cent copper, and 4.27 oz. of silver per ton. The 435-meter level is now being developed.

Santa Rosa Mining Company, at Jose Panganiban, Camarines Norte, in the Philippine Islands, is maintaining an extensive program of underground development. Gold ore will be treated in the mill and cyanide plant now under construction, shown in the illustration presented above

AFRICA

Tax Concession Given Rhodesian Gold Miners

New regulation expected to encourage greater development of properties—Diamond rush near Kimberley regulated by ballot

▶ Southern Rhodesia's Government is granting two important concessions to the gold-mining industry. One of these is a reduction of the maximum rate of income taxation from 4s. 3d. in the pound to 3s. 9d. The other is the exemption from royalty payments of small mines. These concessions are the acceptance of a plan recommended by the Rhodesia Chamber of Mines. It had been pointed out that the Government purchased the royalties from the British South Africa Company for £2,000,000 and that its income from them was at the rate of 9 per cent on the investment. The new arrangement will give great stimulus to the development and working of Southern Rhodesia's gold mines.

▶ One Southern Rhodesia company, Wanderer Consolidated, has decided to erect another reduction plant of 2,000 tons per month capacity, development work having proved a good tonnage of payable ore in its Surprise mine. Preparations have already started. Wanderer Consolidated has a low operating cost. It was only 10s. 2d. per ton the past quarter, and this was up 5d. per ton from the previous quarter.

▶ The Transvaal gold output was 982,964 oz. in April, against 1,012,516 oz. in March, but the daily average was 32,765 oz. in April as compared with 32,662 oz. the preceding month. The number of natives employed has now reached the unprecedented total of 316,359.

▶ A diamond rush which is being compared with the Klondike gold rush is reported from Barkly West, which is 57 miles northwest from Kimberley. Two fissures have been discovered in a dike formation of micaceous kimberlite with little or no augite, described as very rich. The rush was made orderly by a ballot, the prospectors being released in rotation. It is not desired to forecast failure, but the number of the man first drawn was 472 (the sum of which is 13), the second man permitted to peg a claim hailed from Badhope, and the Smith's mine in the district, on which operations have recently been resumed privately, is said to have worked a deposit shaped like a dumbbell.

▶ Roan Antelope's net earnings for the March quarter, after an allowance of £50,000 for replacements and obsolescence but subject to taxation, was £284,000. As gross revenue for the March quarter was £733,000 and the price of copper averaged £40 5s. 10d., production appears to have been slightly less than 18,000 long tons of blister, or at the rate of 71,000 tons annually. Its quota is 70,812 tons; gross revenue is the amount settled for, and settlements during the March quarter would have been in part for copper shipped from Rhodesia months earlier and sold for higher prices.

▶ Mufulira Copper Mines reports an estimated profit of £206,000 for the March quarter. Gross revenue indicates that Mufulira's production was up to a rate of 4,715 tons monthly, or near its quota of 5,200 tons a month. By the end of this year Mufulira should be capable of a production of 7,000 long tons monthly.

Higher Gold Price In Japan

▶ On April 30 the Japanese Ministry of Finance announced an increase in the official gold purchase price from 3.77 yen per gram to 3.85 yen in order to meet the advance in world market prices. The new price is expected to encourage domestic production from the marginal mines. The market price for gold rose on that day from 14.27 yen per momme to 14.40 for buying and 14.30 to 14.60 for selling. A momme equals 0.12057 troy ounce.

FIJI ISLANDS

Good Ore Continues At Loloma Mine

Development on lowest level shows improvement in width of orebody—Prospecting at Koroere proves disappointing

▶ Driving on the 224-ft. level at the Loloma Mine, Fiji, has been resumed, in good values. The drive has now been carried to 773 ft., the last 47 ft. averaging 27 dwt. per ton over 97 in. Latest mill returns indicate that the plant is now completely over its "teething troubles," 2,020 tons being treated in the four weeks to March 23 for the production of 2,650 oz. (26.3 dwt. per ton). Extraction was 92.8 per cent. The adjoining Emperor mine is now in routine production, 12,064 tons having been treated in the same period for a yield of 3,812 oz. (6.32 dwt. per ton). Tailings averaged 0.48 dwt., showing an extraction of 92.4 per cent.

▶ As was expected, directors of Emperor Gold Mines, Tavua, Fiji, have now made an offer to take over the adjoining Koroere leases. The purchase consideration is £25,000, to be satisfied by the issue of 50,000 fully paid 10s. Emperor shares. The offer has been recommended by the Koroere board to its shareholders for acceptance. Exploration of the Koroere leases has yielded rather disappointing results, the total ore developed being only 44,000 tons averaging 9.6 dwt. per ton, and the prospects of further ore could be investigated only at considerable expense, which the Koroere board did not feel was justified in the circumstances.

▶ Loloma has declared its first dividend, the initial return from the Fijian mines. The amount is 1s. per share, and will call for £41,250 Australian. It is expected that similar distributions will be made quarterly in future.

NEW BOOKS

INTRODUCTORY ECONOMIC GEOLOGY. *By W. A. Tarr. McGraw-Hill Book Company, New York and London. Pp. 645. Figs. 256. Price $5.*

THIS is the second edition of Professor Tarr's book, the first having been published in 1930. In the revision he has taken advantage of the progress in geologic knowledge of the mode of occurrence and geographic distribution of mineral deposits and new facts as to their origin. Changes in the economic importance of some earth products are noted, particularly the minerals that have found new industrial uses. Much material has also been added on the metallurgy of the various metals, and production data have been brought up to date.

The treatment is by materials or groups of materials. After a general introduction and a discussion of the principles of the formation of mineral deposits, the author divides the remainder of the book into two parts dealing with metallic earth materials and non-metallic earth materials. The major metals receive extensive consideration, including mineralogy, ore deposition, metallurgy, and a description of the principal deposits throughout the world. The minor metals receive similar, if less extensive, treatment. Non-metallic or industrial minerals are discussed under the topics of coal, petroleum and natural gas, structural materials, materials used chemically, and materials of miscellaneous uses. Each chapter is supplemented with a bibliography of selected reading. Mr. Tarr's new volume admirably serves its purpose as an introductory textbook.

GROUND WATER. *By C. F. Tolman. McGraw-Hill Book Company, New York and London. Pp. 593. Figs. 189. Price $6.*

IN HIS PREFACE the author, who is professor of economic geology at Leland Stanford Junior University, states that "This book records the birth and describes the development of a new science—coordinated scientific data regarding the occurrence, motions, and activities of subsurface water, and the hydrologic properties of water-bearing materials—christened by O. E. Meinzer 'Ground-water Hydrology'." Professor Tolman's book is a pioneer in its field, being the first general treatise of the science published in the English language, and the only one to attempt a summary of the results of intensive study of subsurface waters in western United States.

Geologists and engineers, as well as students of geology and engineering, will find this book a valuable guide to the subject. Of particular interest to mining men are the author's discussions of the hydrologic properties of rocks and water-bearing materials other than soils, and the occurrence of ground water in fractures and solution openings. The development of water supplies from confined water, and the geological classification of artesian structures, are also pertinent to the mining geologist's work.

Inasmuch as a new science has its own language that may not be generally familiar, the author has included a glossary of terms used in the text. Hydraulic conversion factors are given in an appendix.

HOW TO HANDLE GRIEVANCES. *By Glenn Gardiner. Elliott Service Company, New York, N. Y. Price according to quantity. Board covers, 60¢ to 33¢ per copy. Paper binding, 45¢ to 25¢*

A TIMELY BOOK by a competent author who is assistant to the president of the Forstmann Woolen Company, Passaic, N. J. In his experience he has worked as a laborer, skilled mechanic, foreman, personnel manager, and director of foremen's training for large manufacturers. The book is organized for practical use by all who have to deal with labor in mills and factories. It is a working manual, in which 26 aspects of grievances are analyzed, and as many solutions offered to an equal number of daily problems. Each topic is treated on a single page, and the opposite page is reserved for notes by the user. Mr. Gardiner has gone to the root of many minor matters that sometimes grow into important industrial disputes. Believing that an ounce of prevention is worth a pound of cure, he has produced a human document of great value that is peculiarly applicable to current labor conditions.

PUBLICATIONS

RECEIVED

✦ *Map of Katanga-Sakabinda Sheet. Accompanied by a 48-page descriptive pamphlet (in French).* Published by Comité Special du Katanga, Rue des Petits-Carmes, 51, Brussels, Belgium.

✦ *Geological Survey of Newfoundland, St. John's.* Bull. No. 8: Geology of the Sops Arm Area, White Bay, by George R. Heyl. Bull. No. 10: Geology and Mineral Deposits of Hawke Bay, Great Harbour Deep Area, by Frank C. Foley. Bull. No. 11: Marble Deposits of Northern Newfoundland, by George W. Bain.

✦ *Ein Interglazialfund bei Rouhiala in Südostfinnland.* By Gunnar Brander. Bulletin 118. Geological Commission of Finland, Helsingfors. Pp. 83. Also Bulletin 117, entitled "Das Sotkamo-Gebiet in Spätglazialer Zeit.." By Sampo Kilpi. Pp. 124, with map and plates.

✦ *William Tyrrell of Weston.* By E. L. Morrison and J. E. Middleton. A romantic biography of a many-sided personality who exerted a profound influence in the development of Ontario, and whose sons, Joseph and James, gained fame as geologists in Canada. Published by The Macmillan Company of Canada, St. Martin's House, Toronto, Canada. Price $3.

✦ *Annuaire, 1937. Bureau d'Etudes Geologiques et Miniéres Coloniales. 13 rue de Bourgogne, Paris. VIIe.* This year book contains a 115-page section of mineral statistics, also a 136-page section on the mining companies in French colonies, in addition to much other information bearing on the mining industry in France's overseas possessions. Pp. 526.

✦ *Reconnaissance of Mining Districts in Clark County, Nevada.* By W. O. Vanderburg. Information Circular 6964. U. S. Bureau of Mines, Washington, D. C.

✦ *Methods and Costs of Mining and Crushing Gypsum at the Mine of Victor Plaster, Inc., Victor, New York.* By E. J. Lintner. Information Circular 6967. U. S. Bureau of Mines, Washington, D. C.

✦ *Earth Vibrations Caused by Quarry Blasting.* Progress Report No. 1. By J. R. Thoenen and S. L. Windes. Report of Investigations 3353. U. S. Bureau of Mines, Washington, D. C.

✦ *Gold Lode Mining in the Tobacco Root Mountains, Madison County, Mont.* By S. H. Lorain. Information Circular 6972. U. S. Bureau of Mines, Washington, D. C.

✦ *Quicksilver in Oregon.* By C. N. Schuette. Published by the State Department of Geology and Mineral Industries, 704 Lewis Building, Portland, Ore. Pp. 172. Price $1.15.

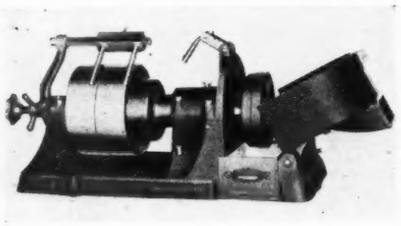
✦ *Australian Investors' Handbook.* Contains financial and technical data on Australian mines. Sent on application to S. C. Ward & Company, 30 Grenfeld St., Adelaide, Australia.

✦ *The Labor Crisis in the United States.* By George E. Sokolsky. John Wiley & Sons, Inc., New York; Chapman & Hall, London. Pp. 30. Price $0.25. A review of the current battle for power in American industry; characteristics of the labor movement in the United States; with an outline of policy for free labor in a democratic society.

EQUIPMENT NEWS

New Pulverizer

DENVER Fire Clay Company, Denver, Colo., announces its new pulverizer, incorporating a radical improvement in the grinding action by means of "Direct, Gyro-Shaft Drive." The driven disk rotates at 850 to 900 r.p.m.—and at the same time travels through a secondary orbit created by the revolving of an eccentric sleeve bearing, through which the main shaft turns. Innumerable tests prove that maximum capacity, protection against grooving of the disks, and even accurate control of fineness depend upon a correct relation between the revolutions of the disk and the speed of travel in its secondary orbit. In the DFC pulverizer this relationship is said to be scientifically correct. All bearings and gears run in a constant bath of oil from a generous reservoir in the front standard—oil ring feed and gravity return. Absence of gear trains, manufacture to close tolerances, and rotary action of moving parts make this pulverizer remarkably smooth-running and vibrationless. Adjustment of fineness is made with one hand wheel and a lock nut at the rear of the machine. Adjustment is not affected by opening the grinding chamber cover. The pulverizer is available in two models—one for flat-belt drive, equipped with tight-and-loose pulleys and belt throw; one complete with electric motor and V-belt drive integral with machine.



Metal Swing Joint

CHIKSAN Oil Tool Company, Ltd., Fullerton, Calif., announces the development of a ball-bearing all-metal swing joint which is said to be adaptable for all installations where movement is a factor. Double rows of hardened steel balls not only carry all radial loads, but also maintain a pre-regulated thrust load upon the packing element, keeping it always pressure-tight and leak-proof. It is claimed the joint cannot bind or get out of adjustment. There is nothing to interfere with free and complete 36-deg. swivelling, and the streamlined exterior has no projections to catch workmen's clothes. There are no packing glands to require constant tightening, and the joint is unaffected by heat, cold, and a variety of corrosive fluids. These joints are avilable in a wide variety of rotating actions, in steel, malleable iron, or aluminum. Sizes range from ¾ in. to 12 in. (and up to 18 in. on special order). They come in threaded, flanged, or plain ends for connecting into all kinds of pipe, and are made for both high and low pressures.

Manasite Blasting Cap

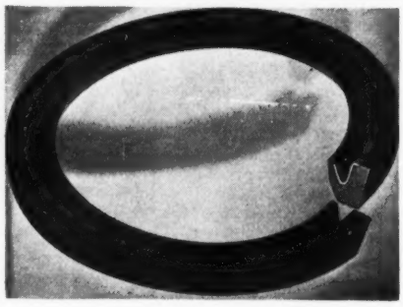
ATLAS Manasite blasting caps and Electric blasting caps are announced by Atlas Powder Company, Wilmington, Del., as representing a real advance in safety for all users of explosives. The company points out that no detonator should properly be called "safe," as it is intended to set off explosives. The new Manasite detonators, however, are said to increase substantially the margin of safety in handling explosives. Manasite detonators contain a new initiating compound known chemically as hexanitromannite, that is said to be much less sensitive to impact and friction than detonating compounds commonly used.

Variable-Speed Control

REEVES PULLEY COMPANY, Columbus, Ind., manufacturers of variable-speed control equipment, announces a new type of automatic and remote control for use with the Reeves Vari-Speed Motodrive.

The new control, known as fluid pressure control, is available for all units of motodrive. It can be used to regulate speed automatically from pressure variation, as in stoker feed on a boiler, maintenance of constant fluid pressure in a pipe line or tank upon which there is variable demand, uniform tension between machine sections or between a machine and rewinder, and similar requirements for automatic speed control. It may also be used as a manual remote control or as a semi-automatic manual control in different ways.

Fluid pressure is transmitted by means of oil, water, steam, gas, or air by a valve through piping to the bellows-shifting mechanism, which operates to increase or decrease speed on the motodrive and hence on the driven machine.



The Garlock Packing Company, Palmyra, N. Y., has announced a new patented oil seal which is split or cut open and can be easily installed without dismantling the machine. This new product is called the Garlock Split-Klozure

Revolving Welding Table

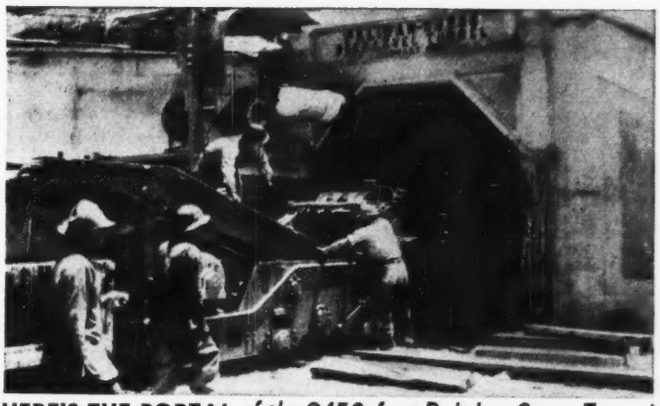
THE WELDING Division of the Ransome Concrete Machinery plant at Dunellen, N. J., announces a revolving welding table, said to be specially advantageous for welding on tanks and other circular products. The entire device weighs about 990 lb. and consists of few parts. In this unit the table is 31 in. in diameter and 25 in. high when horizontal. It has eight lines of radial slots for bolting the work to it. It is tilted by hand operated self-locking worm and wheel. The table tilts to a vertical position either side of the center line and in this position will carry a load of 600 lb. with a maximum diameter of 34 in. Work on larger diameter can be carried in the vertical position on one side of the center.

The table is driven by ¼ hp. electric motor driving through a variable-speed transmission and worm-gear reducer. Range of table speed is said to be 0.055 to 0.333 r.p.m., corresponding to welding speeds of 0.43 to 2.6 ft. per minute, on a 30-in. diameter. Speed is adjusted by a handwheel on the side of the housing. The drive is reversible and the table can be driven in either direction. An average saving of 30 per cent to 50 per cent on welding labor on all cylindrical or circular products is said to have been experienced.

Submersible Pump

BYRON JACKSON Company, Dept. 112, Los Angeles, Calif., announces a submersible deep-well turbine pump that has the motor below and not above the turbine bowls. The small-diameter motor operates submerged at all times in the well water, but the liquid pumped does not come in contact with the electrical

World's Record for Tunnel Driving with WORTHINGTON PNEUMATIC-FEED DRIFTERS



HERE'S THE PORTAL *of the 9450-foot Palidan-Suyoc Tunnel*

HERE'S THE DRILL CARRIAGE *used in driving the Palidan-Suyoc Tunnel. On it are mounted four 3½-inch Worthington Pneumatic-feed Drifters*

HERE'S THE WORTHINGTON DRIFTER *used on the Palidan-Suyoc Tunnel. One of four, it has proved its dependability on many important tunneling jobs in all parts of the world*

THE Palidan-Suyoc Deep-level Tunnel is the first drainage tunnel to be driven in the Philippines using modern methods and equipment. In overcoming natural and human obstacles, the tunnel has been driven with greater speed and at much lower cost than mining men had thought possible. The 1327 feet made in July, 1937, set a new world's record for tunnel driving. This performance becomes particularly notable in the light of the type of labor available and the character of rock encountered.

Four 3½-inch Worthington Pneumatic-feed Drifters helped to set this new world's record. Faster drilling speed, low air consumption, negligible maintenance and the ability to "take it" under the severest operating conditions, make the performance of these drifters noteworthy.

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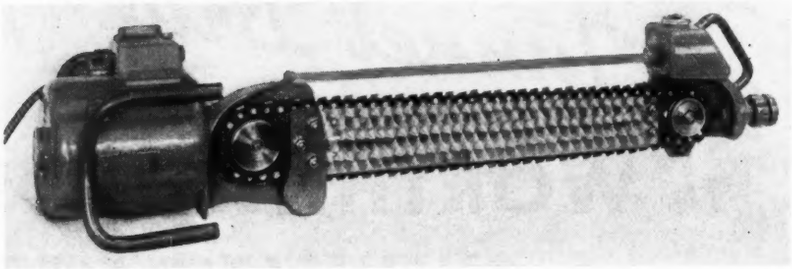
RDB-1

Portable Electric or Gasoline Chain Saws



A handy, fast-operating, and light-weight portable saw for mine timber framing and other various uses is announced by The Vulcan Iron Works, Denver, Colo. The electrically operated Type D saw ranges in size from 14 in. to 58 in. long, requiring from 1.5 hp. to 8 hp., respectively. Type E is for direct current. The Type C Unit is gasoline-operated, and ranges in size from 26 in. to 58 in. long, requiring from 5 hp. to 7 hp. and weighting from 95 to 132 lb., respectively.

parts or motor bearings, as these are inclosed in an oil-filled case with a mercury seal where the shaft passes through the top. The turbine and the submersible motor form a compact unit that is attached to and supported by the discharge pipe. This submersible pump is said to operate equally well, and without frequent attention, in deep or shallow wells, crooked or straight wells, sumps, or natural bodies of water.

BULLETINS

Mill Equipment Catalog. Western Machinery Company, 760 Folsom St., San Francisco, Calif. Attractive booklet describes mechanical agitators, thickeners, classifiers, diaphragm pumps, ore feeders, and other machinery used in cyanide and flotation mills. Pp. 17. Catalog No. 5M138.

"5 Minutes with Silver Contacts." An 8-page bulletin of the General Electric Company, Schenectady, N. Y., explaining why the company chose silver for electrical contacts, and demonstrating the trend toward the use of silver for this purpose.

Speed Indicator. Herman H. Sticht & Co., 27 Park Place, New York, N. Y. Bulletin 715 describes the manufacturer's type of r.p.m. and f.p.m. speed indicators. Pp. 2.

Diamond Drills. E. J. Longyear Co., Minneapolis, Minn. Bulletin 42 contains illustrations and description of Longyear Straitline diamond core drills, Junior and U. G. models. Pp. 7.

No-Thread Pipe Fittings. S. R. Dresser Mfg. Co., Bradford, Pa. Catalog profusely illustrates various industrial uses of the manufacturer's self-contained pipe joints that connect pipe without threading. Pp. 15.

Soldering Tools. Ideal Commutator Dresser Co., 1958 Park Ave., Sycamore, Ill. Folder describes a new all purpose Thermo-Grip soldering unit. Pp. 4.

Steam-Jet Ejectors. Ingersoll-Rand Co., Phillipsburg, N. J. Bulletin 9046 describes the manufacturer's single, two- and three-stage steam jet ejectors for removing air, gas, or vapors from condensers, and vacuum chambers in industrial processes. Pp. 27.

Plugs and Sockets. General Electric Co., Schenectady, N. Y. Leaflet GEA-2638 describes plugs and sockets for storage battery locomotives. **Magnetic Switches.** GEA-1590C leaflet describes magnetic switches for installation in corrosive armosphere. **Push-button Stations.** GEA-2473 Bulletin gives complete line of stations available and accessories. **Gasoline-Driven Arc Welder.** Folder GEA-2776 describes Ford V-8 gasoline engine-driven arc welder. Pp. 3. **Recording Instruments.** Folder GEA-2635 describes strip chart recording instruments. Pp. 4. **Air Breaker Equipments.** Bulletin GEA-2728 describes equipment for low-voltage a.c. circuits.

Amalgamator. Mill & Mine Supply, Inc., 2700 Fourth Ave., So., Seattle, Wash. Illustrated folder describes the company new rotary amalgamator. Construction details and operating data are given. Pp. 4.

Hydraulic Diaphragm Jig. Mill & Mine Supply, Inc., 2700 Fourth Ave., South, Seattle, Wash. Bulletin describes and illustrates the Titan hydraulic diaphragm-jig manufactured by the company. Pp. 2.

Pulp-Density Controller. Mine & Smelter Supply Co., Denver, Colo. Leaflet describing automatic device for maintaining uniform density in classifier overflow. Pp. 40.

Pumping-Plant Panels. Square D Co., Los Angeles, Calif. Bulletin describes features of company's panels for use in pumping plants. Pp. 2.

Engines and Power Units. Allis-Chalmers, Milwaukee, Wis. Catalog 175-224 describes and illustrates engines and power units using gasoline, kerosene, and natural gas. Specifications of units are given. Pp. 23.

Primary Batteries. Edison Signal Batteries, Bloomfield. N. J. Booklet describes batteries for electric lighting of switch lamps. Pp. 11.

Electric Sampler. General Engineering Co., Salt Lake City, Utah. Bulletin 702 describes and illustrates features of the company's electric sampler. Pp. 12.

Eye-Protection Guide. American Optical Co., Southbridge, Mass. A chart which specifies types of safety goggles to wear for protection against eye hazards in all principal industries. Pp. 2.

Rotary Positive Blowers. Roots-Connersville Blower Corp., Connersville, Ind. Bulletin 21-B-19 discusses positive movement of air by the Company's Victor-Acme rotary positive blowers. Pp. 8.

Pillow Blocks. Palmer-Bee Co., Detroit, Mich. Folder describes cast-steel self-aligning pillow blocks equipped with Hyatt roller bearings. Pp. 2.

Cable. Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y. Publication C-39 describes and illustrates features of new "ANW" non-metallic sheathed-duct cable for low-voltage secondary network service. Pp. 7. C-41 describes varnished cambric cables. Pp. 35.

Power-Transmission Equipment. Denver Equipment Co., 1400-1418 Seventeenth St., Denver, Colo. Catalog 52 is pocket size and contains illustrations, specifications, and price list for power-transmission equipment manufactured by Boston Gear Works. Pp. 319.

Slime Table. Deister Concentrator Co., Fort Wayne, Ind. Bulletin 18-D describes the manufacturer's diagonal-deck Deister-Overstrom sand or slime table. Pp. 4.

Modern Refractory Practice. Harbison-Walker Refractories Co., Pittsburgh, Pa. A handsomely made up book containing twenty divisions and an index. Various types of refractories are described, special clays are discussed, and description is made of the company's research in the field of refractories. A glossary of terms commonly used in the refractory industry is given and a chapter of general information of interest in connection with refractories. Tables of brick combinations required for circles and for arches are also included. Pp. 295.

INDUSTRIAL NOTES

Announcement has been made of the appointment of J. T. Lusignan, Jr., as executive engineer of the Ohio Brass Company, Mansfield, Ohio. Formerly engineering assistant to the vice-president, Mr. Lusignan will now supervise all engineering activities of the O. B. organization.

The Illinois Zinc Company's new zinc rolling mill on 47th St. at Sacramento Ave., Chicago, in the Kenwood manufacturing district, was recently completed. General offices of the company were established May 1 in the new plant, which was designed and built by the Austin Company. Equipment includes latest type of electrically controlled rolling mills and special furnaces for alloying zinc and other metals from which strip zinc and alloys of improved quality will be produced. The company operates mines at Hanover, N. M., a smelter at Dumas, Tex., and its sheet mills at Peru, Ill., the latter having been in operation since 1870.

Electric Storage Battery Company, manufacturer of Exide batteries, began this month (June) to observe its golden anniversary year. The company, which enjoys the distinction of being the largest manufacturer of storage batteries in the world for every purpose, was founded in June, 1888, in a small, one-story brick structure near Gloucester, N. J. The company expanded and grew, and in 1919 a 40-acre tract of land was purchased at Crescentville on the northeastern edge of Philadelphia, where the most modern battery-building plant in the world was erected.

W. W. Gibson, manufacturer of mining machinery, has moved his office from 112 Market St., San Francisco, to 1801 Webster St., Alameda, Calif.

John R. Cassell was recently promoted from the position of general sales manager to that of vice-president in charge of sales of the Ozalid Corporation, of New York City.

General Cable Corporation announces the change in address of its Chicago office from 20 North Wacker Drive to 111 North Canal St. Telephone connection, Franklin 1101, remains unchanged.

An interesting demonstration of the manufacture of tungsten metal was given at the "open house" celebration of the opening of the Cleveland Tungsten Manufacturing Company's new plant at 10200 Meech Ave., Cleveland, Ohio, May 2 last. E. O. Oberdick, president of the company, explained that the plant is now equipped for the manufacture of tungsten metal by both the hydrogen and the carbon reduction processes.

Foote Mineral Company, 1609 Summer St., Philadelphia, Pa., announces that L. G. Bliss has returned to the company in the position of sales engineer.

Concentrating Southern Barite Ores

THE barite-mining industry in the United States was unimportant prior to the World War, but with the cessation of imports during that war the American manufacturers of lithopone and barium chemicals forced the development of domestic barite deposits. Primarily because of the increasing demand for lithopone [1] by the paint, floor-covering, and rubber industries, development of domestic deposits has continued to expand. In 1914 the sales of domestic crude barite amounted to 52,919 tons, and in 1935 225,111 tons were sold; the latter represented 77.53 per cent of the total, domestic and imported, barite used in the United States during that year. Of the total 290,344 tons consumed in the United States in 1935, 32.3 per cent was used as ground barite,[2] 50.3 per cent as lithopone, and 17.4 per cent in the manufacture of barium chemicals.

Although economically important barite deposits occur in at least twenty states, only California, Georgia, Missouri, Nevada, South Carolina, Tennessee, and Virginia reported sales of barite in 1935. Of the three main marketing areas—the Pacific Coast, the Mid-Western, and the Eastern—the Eastern is the chief competitive area; for not only is most of the Southern barite marketed there, but also part of the Mid-Western and practically all of the foreign barite. Quite a number of producers and potential producers have found it difficult to compete in this Eastern area because of impurities in their ores. The simple log-washing process, which has proved satisfactory in a few instances, is entirely inadequate for most of the Southern ores.

With a view to increasing the reserves of marketable barite by determining the availability of concentration methods for treatment of low-grade ores, the Bureau of Mines, with the cooperation of the University of Alabama, began an investigation in 1934 of the amenability of Southern barite ores to table concentration and froth flotation.

Representative samples of ore, obtained from Bibb County, Ala.; Kings Creek, S. C.; Stackhouse, N. C.; Sweetwater, Tenn.; and Nolansville, Tenn., were the basis of the investigation. Samples from Nolansville, Tenn., Stackhouse, N. C., and Kings Creek, S. C., represent vein deposits; all other samples were from residual deposits resulting from disintegration of sedimentary rocks. The samples from Sweetwater, Tenn., included a mill product from a washing plant at an operating mine. All of the properties from which samples were taken are either inactive or hampered in their operation because of impurities in the ore. Gangue minerals in the various samples were principally calcite, iron oxide, fluorite, and quartz. The compositions of the samples are shown in Table I. Ores represented by samples "A," "B," and "J" are sufficiently pure without beneficiation, but sample "E" is suggestive of a fluorspar rather than a barite ore.

Table Concentration — The specific gravity of barite is from 4.3 to 4.6 and that of the gangue minerals ranges from 5.2 for the heaviest iron oxide minerals to 2.6 for quartz. The selection of the samples for table-concentration tests was based on the relative specific gravities of the ore constituents and the degree to which gangue minerals were liberated by crushing the sample to a size suitable for tabling. Classification and table tests were made on ores C, D, and K only, as the preliminary float-and-sink tests showed that in the case of Ore I the

TABLE I—Source and Composition of Barite Samples

Ore	Source	Assay, Per Cent $BaSO_4$	CaF_2	$CaCO_3$	Fe_2O_3	SiO_2
A	Bibb County, Ala	96.0	0.2	0.7	0.6	Trace
B	Bibb County, Ala	95.2	0.3	Trace	0.5	Trace
C	Bibb County, Ala	72.0	16.7	8.1	1.1	2.0
D	Bibb County, Ala	81.6	7.9	8.6	Trace	1.6
E (a)	Nolansville, Tenn	34.9	55.1	2.3	Trace	....
F	Sweetwater, Tenn. (mill concentrate)	92.4	None	Trace	1.7	....
G	Sweetwater, Tenn	87.4	4.6	1.5	5.4	....
H	Sweetwater, Tenn	86.1	None	Trace	11.0	....
I	Stackhouse, N. C	94.6	4.4	0.5	Trace	....
J	Stackhouse, N. C	96.1	0.4	0.6	Trace	....
K	Kings Creek, S. C	73.5	Trace	0.7	0.5	22.0

(a) This ore contained 5.2 per cent PbS.

TABLE II—Results of Classification and Tabling of Ore C

Table Products	Weight, Per Cent of — Table Feed	Weight, Per Cent of — Total Ore	Assay, Per Cent $BaSO_4$	Assay, Per Cent CaF_2	Distribution, per Cent — Table Feed $BaSO_4$	Distribution, per Cent — Table Feed CaF_2	Distribution, per Cent — Total Ore $BaSO_4$	Distribution, per Cent — Total Ore CaF_2
Spigot 1:								
Zone 1 to 3	50.4	12.9	97.0	1.0	55.8	5.8	17.5	0.7
Zone 4	13.9	3.6	96.1	3.9	15.2	6.5	4.8	0.8
Zone 5	13.8	3.5	94.0	5.9	14.8	9.8	4.7	1.2
Zone 6	4.2	1.1	80.0	6.5	3.8	3.3	1.2	0.4
Zone 7	5.5	1.4	77.8	18.0	4.9	12.0	1.5	1.5
Zone 8 to 19	12.2	3.1	39.3	42.4	5.5	62.6	1.7	7.7
Composite feed	100.0	25.6	87.7	8.3	100.0	100.0	31.4	12.3
Spigot 2:								
Zone 1 to 5	45.1	7.7	97.7	0.3	64.9	0.5	10.5	0.1
Zone 6	5.0	0.9	96.2	0.6	7.1	0.1	1.1	0.02
Zone 7	8.5	1.4	96.3	3.2	12.0	1.3	1.9	0.3
Zone 8	14.9	2.5	59.1	37.0	13.0	25.3	2.1	5.4
Zone 9 to 19	26.5	4.5	7.8	59.8	3.0	72.8	0.5	15.6
Composite feed	100.0	17.0	67.9	21.8	100.0	100.0	16.1	21.4
Spigot 3:								
Zone 1 to 6	25.3	4.0	98.7	0.1	40.8	0.04	5.5	0.01
Zone 7	8.6	1.3	98.7	0.1	13.9	0.01	1.9	....
Zone 8	2.9	0.5	98.7	0.2	4.7	0.02	0.6	0.01
Zone 9	8.5	1.3	97.7	0.7	13.5	0.24	1.8	0.06
Zone 10 to 19	54.7	8.5	30.4	48.0	27.1	99.69	3.6	23.7
Composite feed	100.0	15.6	61.3	26.4	100.0	100.0	13.4	23.8
Classifier overflow:								
Zone 1 to 2	15.9	6.7	99.1	0.4	23.6	0.4	9.2	0.2
Zone 3	5.8	2.4	96.9	1.4	8.4	0.5	3.3	0.2
Zone 4	6.3	2.6	96.0	2.5	9.1	0.9	3.6	0.4
Zone 5	7.9	3.3	90.0	8.0	10.6	3.6	4.1	1.5
Zone 6	4.2	1.8	72.9	19.9	4.6	4.7	1.8	2.0
Zone 7 to 19	59.9	25.0	48.7	26.4	43.7	89.9	17.1	38.2
Composite feed	100.0	41.8	66.8	17.6	100.0	100.0	39.1	42.5
Total ore, composite	....	100.0	71.5	17.3	....	....	100.0	100.0

Note: If Zones 1 to 5, 1 to 7, 1 to 9, and 1 to 5 of classifier products Spigot 1, Spigot 2, Spigot 3, and overflow, respectively, are considered as concentrate zones, the composite of these concentrates, on the basis of the proportional weights, will have an analysis of 1.8 per cent CaF_2 and 96.7 per cent $BaSO_4$. The recovery of $BaSO_4$ in these concentrates is 68.1 per cent of the total $BaSO_4$ in the original ore. The rejection of CaF_2 in the tailings is 94.6 per cent of the total CaF_2 in the original ore.

[1] Lithopone is a white pigment consisting of a mixture of approximately 70 per cent barium sulphate (barite) and 30 per cent zinc sulphide.

[2] Finely ground barite, both bleached and unbleached, is used principally as a filler for paints, rubber, linoleum, oilcloth, and glazed paper.

TABLE III—Results of Classification and Tabling of Ore D

Table Products	Weight, per Cent of —		Assay, per Cent			Distribution, per Cent: Table Feed			Distribution, per Cent: Table Ore		
	Table Feed	Total Ore	$BaSO_4$	CaF_2	$CaCO_3$	$BaSO_4$	CaF_2	$CaCO_3$	$BaSO_4$	CaF_2	$CaCO_3$
Spigot 1:											
Zone 1 to 3	50.0	12.9	98.4	0.5	0.8	52.2	5.7	31.2	15.5	0.7	1.2
Zone 4	15.0	3.8	98.8	0.8	0.8	15.6	3.2	9.0	4.6	0.4	0.3
Zone 5	16.2	4.2	96.7	1.7	0.9	16.7	6.9	11.0	5.0	0.9	0.4
Zone 6	8.3	2.1	94.7	3.2	1.1	8.3	6.7	7.1	2.5	0.8	0.3
Zone 7	6.1	1.6	84.5	12.2	1.8	5.5	19.0	8.5	1.6	2.4	0.3
Zone 8 to 19	4.4	1.1	35.9	52.2	9.7	1.7	58.5	33.2	0.5	7.4	1.2
Composite feed	100.0	25.7	94.2	4.0	1.3	100.0	100.0	100.0	29.7	12.6	3.7
Spigot 2:											
Zone 1 to 3	48.3	6.5	98.5	0.3	0.8	63.8	1.4	3.0	7.8	0.3	0.6
Zone 4	10.4	1.4	97.7	0.8	0.9	13.6	0.7	0.7	1.7	0.1	0.1
Zone 5	11.4	1.6	92.2	4.5	1.5	14.1	4.5	1.3	1.7	0.9	0.3
Zone 6	7.6	1.0	54.5	39.6	3.9	5.5	26.4	2.2	0.7	5.0	0.4
Zone 7 to 19	22.3	3.0	9.9	34.2	54.4	3.0	67.0	92.8	0.4	12.7	17.8
Composite feed	100.0	13.5	74.6	11.4	13.1	100.0	100.0	100.0	12.3	19.0	19.2
Spigot 3:											
Zone 1 to 4	29.4	4.2	98.4	0.2	0.7	39.3	0.4	1.5	5.0	0.1	0.3
Zone 5	9.5	1.3	98.3	0.4	0.8	12.7	0.3	0.6	1.6	0.1	0.1
Zone 6	4.4	0.6	97.1	1.1	0.9	5.8	0.4	0.3	0.7	0.1	0.1
Zone 7	9.8	1.4	97.1	0.9	0.9	12.9	0.7	0.7	1.7	0.1	0.1
Zone 8	18.1	2.6	89.0	7.8	1.7	21.9	11.6	2.4	2.8	2.5	0.5
Zone 9 to 19	28.8	4.1	18.8	36.6	43.2	7.4	86.6	94.5	1.0	18.4	19.3
Composite feed	100.0	14.2	73.6	12.2	13.2	100.0	100.0	100.0	12.8	21.3	20.4
Classifier overflow:											
Zone 1 to 5	38.8	18.1	98.0	0.6	1.1	48.1	2.9	3.7	21.7	1.4	2.1
Zone 6	4.0	1.8	95.4	2.2	1.5	4.8	1.1	0.5	2.2	0.5	0.3
Zone 7	8.1	3.8	91.8	4.2	2.6	9.4	4.1	1.9	4.2	1.9	1.1
Zone 8	14.3	6.7	60.9	26.5	11.1	11.0	46.0	14.1	5.0	21.7	8.0
Zone 9 to 19	34.8	16.2	60.7	10.9	25.7	26.7	45.9	79.8	12.1	21.6	45.2
Composite feed	100.0	46.6	79.1	8.2	11.2	100.0	100.0	100.0	45.2	47.1	56.7
Total ore, composite	....	100.0	81.6	8.1	9.2	....	....	....	100.0	100.0	100.0

Note: If zones 1 to 6, 1 to 5, 1 to 8, and 1 to 7 of classifier products Spigot 1, Spigot 2, Spigot 3, and overflow, respectively, are considered as concentrate zones, the composite of these concentrates, on the basis of their proportional weights, will have an analysis of 1.4 per cent CaF_2, 1.0 per cent $CaCO_3$, and 97.0 per cent $BaSO_4$. The recovery of $BaSO_4$ in these concentrates is 78.8 per cent of the total $BaSO_4$ in the original ore.

fluorite was too intimately mixed with the barite to be liberated satisfactorily at a size suitable for tabling, and Ore E was so low in grade from the standpoint of barite, and contained so much fluorite, that preliminary tests showed no possibility of eliminating the fluorite sufficiently to produce a commercial grade of barite by tabling. Fluorite is a particularly harmful constituent in barite, a fraction of 1 per cent fluorite rendering the barite unsuitable for use in lithopone manufacture. Ores F, G, and H, carried iron oxide in a form which is of practically the same specific gravity as the barite, and preliminary concentration tests showed no possibility of separating this iron oxide from the barite by classification and tabling. Ores C, D, E, F, G, H, I, and K will be discussed further under "Froth Flotation." The classification and tabling tests were made with small laboratory machines, but it is believed that the results could be duplicated commercially.

To determine the fineness to which the ores must be crushed in order to liberate most of the impurities, float-and-sink separations were made on sized products of each of the samples. The samples were crushed through 10 mesh and sized for the float-and-sink separations that were made in a heavy solution of 3.40 specific gravity. Where the liberation was poor, an additional float-and-sink test was made on 3.82 specific gravity. The results of these tests indicated that ores C, D, E, F, G, H, and K gave fair liberation when crushed to pass 28 mesh. Ore I was poorly liberated even at minus 48 mesh.

After having been crushed in a rod mill to pass a 28-mesh sieve, ores C, D, and K were deslimed and fractionated into three spigot products by means of hydraulic classification. Each of the spigot products and the classifier overflow was tabled separately. The results are shown in Tables II, III, and IV. Table products from Ore C were analyzed for only CaF_2 and $BaSO_4$, as the principal contaminating mineral was fluorite. The combinations of the various zonal fractions referred to in the notes on Tables II, III, and IV were made in such manner as to yield concentrates of marketable grade. The low recoveries on Ores C and D are accounted for largely by the inefficient tabling of the classifier overflow. This material is too fine for satisfactory tabling.

The analyses of products in Table III, Ore D, include $CaCO_3$ in addition to the analyses for CaF_2 and $BaSO_4$. Although calcite is not nearly as detrimental in a barite concentrate as fluorite, these analyses were included in order to show quantitatively the distribution of calcite in the various table fractions.

TABLE IV—Results of Classification and Tabling of Ore K

Table Products	Weight, Per Cent of —		Assay, Per Cent $BaSO_4$	Distribution, per Cent: Table Feed $BaSO_4$	Distribution, per Cent: Total Ore $BaSO_4$
	Table Feed	Total Ore			
Spigot 1:					
Not tabled	100.0	28.2	95.6	100.0	36.6
Spigot 2:					
Zone 1 to 6	59.4	9.8	97.4	67.7	12.9
Zone 7	14.4	2.4	97.6	16.5	3.2
Zone 8	14.4	2.4	81.9	13.8	2.6
Zone 9 to 10	11.8	1.9	14.0	2.0	0.4
Composite feed	100.0	16.5	85.4	100.0	19.1
Spigot 3:					
Zone 1 to 5	52.5	10.4	97.7	75.1	13.8
Zone 6	10.6	2.1	97.2	15.1	2.8
Zone 7	9.8	2.0	51.5	7.4	1.4
Zone 8	9.7	1.9	8.1	1.1	0.2
Zone 9 to 13	17.4	3.5	5.2	1.3	0.2
Composite feed	100.0	19.9	68.3	100.0	18.4
Classifier overflow:					
Zone 1 to 12	11.9	4.2	98.5	21.7	5.6
Zone 13	15.3	5.4	98.1	27.8	7.2
Zone 14	11.1	3.9	91.1	18.7	4.8
Zone 15	11.2	4.0	32.5	6.8	1.8
Zone 16	17.7	6.3	10.1	3.3	0.9
Zone 17 to 19	32.8	11.6	35.8	21.7	5.6
Composite feed	100.0	35.4	54.0	100.0	25.9
Total ore, composite	....	100.0	73.7	....	100.0

Note: Analysis of the composite ore taken for classification and tabling was 73.7 per cent $BaSO_4$ and 22.0 per cent SiO_2. If the total of Spigot 1 and zones 1 to 8, 1 to 6, and 1 to 14 of Spigot 2, Spigot 3, and overflow, respectively, are considered as concentrates, the composite of these concentrates, on the basis of proportional weights, will have an analysis of 96.0 per cent $BaSO_4$. The recovery of $BaSO_4$ in these concentrates is 89.6 per cent of the total $BaSO_4$ in the original ore.

As shown in Table IV, spigot product 1 of Ore K contained 95.6 per cent $BaSO_4$. This product is already of commercial grade and therefore was not tabled.

(To be continued)

—Excerpted from U. S. Bureau of Mines Report of Investigations No. 3376, written by R. G. O'Meara and G. D. Coe, assistant metallurgist and junior metallurgist, respectively, Southern Experiment Station, Tuscaloosa, Ala.